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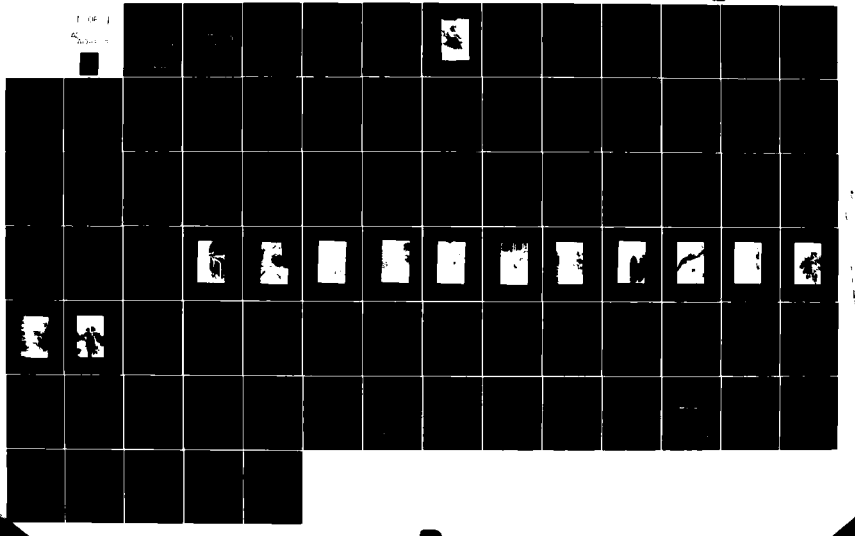

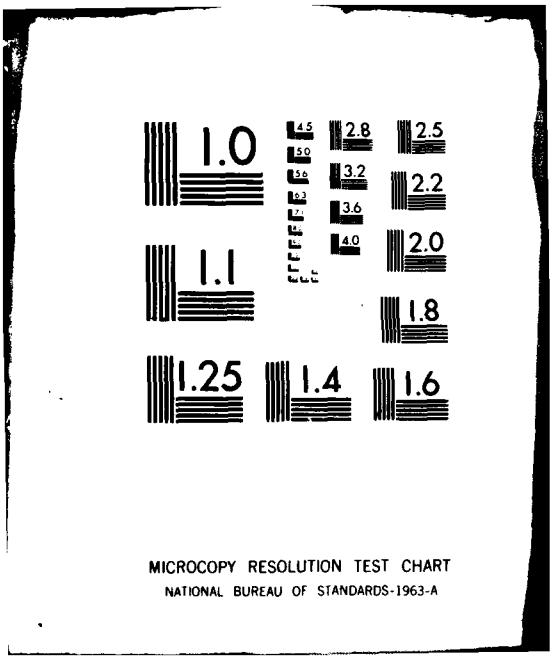
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DELAWARE RIVER BASIN

ALLEGHENY CREEK, BERKS COUNTY

PENNSYLVANIA

NDS ID PA. 00714

DER ID 6-373

LEVEL II

GREEN HILLS DAM

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

WOODWARD-CLYDE CONSULTANTS

DACW31-80-C-0018

ORIGINAL CONTAINS COLOR PLATES: ALL DDC REPRODUCTIONS WILL BE IN BLACK AND WHITE.

DEPARTMENT OF THE ARMY
Baltimore District, Corps of Engineers
Baltimore, Maryland 21203

APRIL 1980

DELAWARE RIVER BASIN

GREEN HILLS DAM
BERKS COUNTY, PENNSYLVANIA

NDS I.D. NO. PA 00714
DER I.D. NO. 6-373

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM. Green Hills Dam. NDS I.D. Number PA-00714, DER I.D. Number 6-373. Delaware River Basin, Berks County, Pennsylvania. Phase I Inspection Report

Prepared by:

Mary F. Beck
John Henry Frederick, Jr

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5120 Butler Pike
Plymouth Meeting, Pennsylvania 19462

DACW31-80-C-0018

Submitted to:

DEPARTMENT OF THE ARMY
Baltimore District, Corps of Engineers
Baltimore, Maryland 21203

APRIL 1980

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PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams for Phase I Investigations. ~~Copies~~ of these guidelines may be obtained from the Office of the Chief of ~~Engineers, Washington, D.C. 20314~~. The purpose of a Phase I investigation is to expeditiously identify those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigations, testing and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify the need for more detailed studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected, and only through continued care and maintenance can these conditions be prevented or corrected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the spillway design flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The spillway design flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

Name of Dam:	Green Hills Dam
County Located:	Berks County
State Located:	Pennsylvania
Stream:	Allegheny Creek
Coordinates:	Latitude 40° 15.7'
	Longitude 75° 54.4'
Date of Inspection:	November 28, 1979

Green Hills Dam is a privately owned dam used for recreational purposes. The embankment of Green Hills Dam is in poor condition, and the spillway structure is in fair condition. The overall rating of the dam is considered to be poor.

In accordance with criteria established by Federal (OCE) Guidelines, the recommended spillway design flood for this "Small" size dam and "High" hazard potential classification is one-half to the full Probable Maximum Flood (PMF). Because of the small estimated capacity of the reservoir and the scattered development along the creek, the selected spillway design flood is one-half the PMF.

Hydrologic and hydraulic calculations indicate that the spillway structure is capable of discharging about 28 percent of the PMF without overtopping the dam under existing conditions. If the crest of the embankment was raised to the original design elevation, the dam would be capable of discharging about 35 percent of the PMF without overtopping. Although one-half the PMF is estimated to cause failure of the embankment by overtopping, the increase in downstream hazard potential is not considered significant. Therefore, the structure is considered to have an "Inadequate" but not "Seriously Inadequate" spillway.

It is recommended that the following measures be undertaken immediately. All work should be performed under the supervision of a registered professional engineer experienced in the design and construction of dams.

1. A hydrologic/hydraulic study should be made to determine the best method of increasing the spillway capacity to meet current hydrologic/hydraulic criteria.

2. All trees on both the upstream and downstream slopes of the embankment should be removed. However, the

long-term stability of the slope should be evaluated in the light of decaying root systems.

3. The crest elevation should be increased to meet the original design elevation.

4. The left spillway retaining wall should be evaluated and repaired.

5. The controls for the 8 and 36 inch conduits should be made operational.

6. The seepage noted downstream of the embankment should be monitored on a regular basis. Any significant increase in seepage amount or development of turbidity should be evaluated by a registered professional engineer experienced in the design and construction of dams.

Because of the location of the dam and the potential for heavy property damage and possible loss of life in the event of high flows or failure, a formal procedure of observation and warning during periods of high precipitation should be developed and implemented for this facility. This procedure should include a method of warning downstream residents that high flows are to be expected. In addition, an operation and maintenance procedure should also be developed to insure that all pertinent items are carefully inspected on a regular basis and maintained in the best possible condition.

Mary F. Beck 4/30/80

Mary F. Beck, P.E. Date
Pennsylvania Registration 27447E
Woodward-Clyde Consultants

4/30/80

John H. Frederick, Jr., P.E. Date
Maryland Registration 7301
Woodward-Clyde Consultants

APPROVED BY:

21 MAY 80

JAMES W. PECK Date
Colonel, Corps of Engineers
District Engineer

OVERVIEW
GREEN HILLS DAM, BERKS COUNTY, PENNSYLVANIA

TABLE OF CONTENTS

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM
GREEN HILLS DAM
NATIONAL ID NO. PA 00714
DER NO. 6-373

SECTION 1
PROJECT INFORMATION

1.1 General.

a. Authority. The Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of inspection of dams throughout the United States.

b. Purpose. The purpose of the inspection is to determine if the dam constitutes a hazard to human life or property.

1.2 Description of Project.

a. Dam and Appurtenances. Green Hills Dam is an approximately 18 foot high earthen embankment across Allegheny Creek. The 570 foot long dam impounds an estimated 270 acre-foot reservoir within a 14.5 square mile drainage basin. The original design drawings indicate that the embankment materials are sand, loam and gravel to be graded from coarse at the surface to fine along a central core wall. The concrete core wall was designed to be 18 inches thick and to extend from the rock at elevations ranging from about 272 to 278 (Plate 2A, Appendix E) to within 1.3 feet of the design crest elevation. A sand and clay puddle wall was to be placed upstream of the concrete core wall from its foundation to the approximate original ground surface. Plate 2, Appendix E, indicates that the left abutment, consisting of a sandstone outcrop, was to be pressure grouted on eight foot centers. There is no other documentation available regarding grouting. The upstream design slope was 2H:1V, and the embankment was protected with rubble paving at the waterline. The crest was designed with a ten foot width at elevation 302.3, and the downstream design slope was also 2H:1V.

A 160 foot long weir is located at the right end of the dam. The height of the weir above the downstream apron ranges from about five feet at the right end to 13 feet at the left end, partially conforming to the rock line of the foundation. The spillway is shown in Photograph 1. The

elevation of the weir is 297, and the elevation of the top of the spillway walls is about 302.5. The spillway discharges into an excavated channel which joins the original stream 450 feet downstream of the spillway.

Outlet works consist of an eight inch cast iron pipe and a 36 inch steel pipe through the spillway at the left end, as shown in Photograph 2. Photograph 8 shows an empty bracket above the upstream end of the outlet works.

b. Location. The dam is located approximately three miles south of the intersection of Interstate Route 176 and U.S. Route 422, in Robeson Township, Berks County, Pennsylvania. The dam site and reservoir are shown on USGS Quadrangle entitled "Reading, Pennsylvania" at coordinates N 40° 15.7' W 75° 54.4'. A regional location plan is enclosed as Plate 1, Appendix E.

c. Size Classification. The dam is classified as a "Small" size structure by virtue of its 18 foot height and its estimated 270 acre-foot total storage capacity.

d. Hazard Classification. A "High" hazard classification is assigned consistent with the potential for extensive property damage and possible loss of life along the Allegheny Creek between the dam and the Schuylkill River, about 3.3 miles downstream.

e. Ownership. The dam is owned by Mr. Charles E. Satterthwait. All correspondence should be addressed to Mr. Satterthwait at Post Office Box 1126, R.D. #1, Mohnton, Pennsylvania 19540.

f. Purpose of Dam. The dam is used for recreational purposes.

g. Design and Construction History. The design drawings for Green Hills Dam are dated 1928 and were revised in 1929. It is believed the dam was constructed shortly thereafter. The dam was designed by Earle M. Frankenhouser for Benjamin P. Gates. No other documentation of the construction history is known to be available.

h. Normal Operating Procedures. Under normal operating procedures, all water flows over the spillway at the right end of the dam.

1.3 Pertinent Data.

A summary of pertinent data for Green Hills Dam and reservoir are presented as follows.

a.	Drainage Area (square miles)	14.5
b.	Discharge at Dam Site (cfs)	
	Maximum Spillway Capacity	
	(existing conditions)	5,370
	(design conditions)	6,654
	Maximum Flood	1,030
	Minimum Required Flow	Unknown
c.	Elevations (feet above MSL)[1]	
	Top of Dam	
	Minimum Existing Crest Elevation	301.5
	Design Crest Elevation	302.2
	Spillway Weir Crest (normal pool)	297.0
	Outlet Works (36 inch pipe)	
	Upstream Invert	Unknown
	Downstream Invert	284.5
	Downstream Bed	283.4±
d.	Reservoir (feet)	
	Length at Normal Pool	2,000
	Length at Maximum Pool	3,000
	Fetch at Normal Pool (est)	1,500
e.	Storage (acre-feet)	
	Normal Pool (estimated)	104
	Top of Dam (estimated)	240
f.	Reservoir Surface (acres)	
	Normal Pool	24
g.	Dam Data	
	Type	Earth with concrete core wall
	Length	570 feet
	Height	18 feet
	Crest Width	12 feet
	Volume	19,000 cubic yards
	Side Slopes	
	Upstream (design)	2H:1V
	Upstream (existing, above waterline)	2.25H:1V

(1) Spillway crest elevation assumed to be 297 from USGS map. All other elevations are relative to this elevation.

	Downstream (design)	2H:1V
	Downstream (existing)	1.8H:1V to 2.8H:1V
	Cutoff	Concrete core wall to rock
	Grout Curtain	Single line grout curtain in left abutment
h.	Spillway	
	Type	Concrete ogee weir
	Location	Right abutment
	Length	160 feet
	Discharge Channel	Excavated channel which rejoins original stream 450 feet downstream of spillway
i.	Outlet works	
	Type	36 inch steel pipe & 8 inch CIP, closed at upstream end
	Upstream invert	Unknown
	Downstream Invert	284.5

SECTION 2
ENGINEERING DATA

2.1 Design.

a. Availability. A summary of the engineering data is presented on the checklist attached as Appendix B. Principal documents containing pertinent data used for this report are limited to design drawings and construction specifications.

b. Design Features. A plan view of the dam and a maximum section are presented in Appendix E. A summary of the design features is included in Section 1.3.

2.2 Construction.

Nothing is known concerning construction beyond the date of the design drawings.

2.3 Operational Data.

There are no operational records maintained for this dam.

2.4 Evaluation.

a. Availability. All information presented herein was obtained from Department of Environmental Resources files and supplemented by conversations with the Owner.

b. Adequacy. The available data are not adequate to evaluate the engineering aspects of this dam.

c. Validity. There is no reason to question the validity of the limited available data.

SECTION 3
VISUAL INSPECTION

3.1 Findings.

a. General. The observations and comments of the field inspection team are contained in the checklist enclosed herein as Appendix A and are summarized and evaluated in the following subsections. In general, the appearance of the facilities indicates that the dam is currently in poor condition and not well maintained.

b. Dam. The vertical alignment of the dam crest was checked, and the profile is shown on sheet 5B, Appendix A. Because of the thick vegetation on the dam crest, the vertical alignment of the dam was estimated by a hand level, using the water level as a base. The crest elevation ranges from 0.7 to 0.9 feet below the top of the wall elevation, adjacent to the spillway, and apparently the original design elevation of the embankment. The upstream slope is heavily vegetated with trees and brush to the waterline, as shown in Photograph 4, and appears to have a slope of 2.25H:1V. Evidence of the original upstream paving was noted during the visual inspection. The crest, which measures 12 feet wide, is also densely covered with vegetation, as shown in Photograph 5. The downstream slope measures from 1.8 to 2.8H:1V, and is shown in Photograph 6.

Waves have damaged some portions of the upstream embankment. Generally, the heavy brush, underbrush and tree growth have protected the slope from waves. A foot traffic path has damaged the crest and slope near the spillway. All junctions between the embankment and left abutment and the right abutment and spillway appear to be in good condition.

Considerable seepage was noted at the left end of the embankment downstream of the dam at the location of the original stream channel; see Photograph 7. Part of this seepage may be attributed to hillside seepage, but seepage either under or through the dam cannot be completely discounted.

c. Appurtenant Structures.

1. Spillway. The 160 foot long spillway is at the right end of the dam. The spillway apron follows the contour of the rock foundation where the top of rock is above the 13.26 feet design height of the spillway. Therefore, the height of the weir above the downstream apron ranges from less

than five feet at the right end of the spillway to about 13 feet at the left end of the spillway. The spillway crest was level and water was flowing over it uniformly. The crest of the far right section has some spalling. All exposed concrete surfaces are rough. The right spillway wall appears in good condition, with no significant cracking, concrete deterioration or movement. The left spillway wall appears to be in a stable condition. However, in three locations, one downstream and two upstream of the weir, vertical cracks through the wall extend from the top to below water level or the floor. The downstream end of the wall is deteriorating, as shown in Photograph 11. Concrete is spalling off the top of the wall, and apparently has been repaired once in the past at that location; see Photograph 9.

2. Outlet Works. Outlet works consist of an eight inch cast iron pipe and a 36 inch diameter steel pipe through the base of the weir adjacent to the left spillway wall, as shown in Photograph 2. Both pipes are closed at the upstream end and appeared dry at the time of inspection. What appears to be a valve stem can be seen underwater upstream of the weir. An empty bracket, attached to the left spillway wall, appears to be above the upstream end of the eight inch pipe. The Owner reported that the valve controlling the 36 inch conduit is operable, but did not know when it was last operated.

d. Reservoir. Reservoir side slopes are flat to moderate and vegetated with trees, grass and brush to the water's edge. There is a considerable amount of sediment being deposited at the upper end of the reservoir. The 1956 USGS map indicates a reservoir surface area of 28.5 acres. The Owner reported that construction of Interstate 176 resulted in sediment accumulation at the upper end of the reservoir. Brush is growing in the sediment deposit areas. The original normal pool surface area was estimated to be 31.5 acres. Reservoir surface area as measured from current USGS maps is 24.9 acres.

e. Downstream Channel. The downstream channel appears to be in good condition. The channel is approximately 40 feet wide with low banks, as shown in Photograph 3. The floodplain is fairly wide below the dam with thick underbrush. Bank undercutting is occurring on the outside bends, generally stopped by rock. Large trees are lying in the channel.

A campsite, shown in Photograph 12, is located on the floodplain and would be destroyed in the event of large flows in Allegheny Creek. The first downstream house which may experience some damage in the event of failure is about 2,000 feet below the dam. About 3,400 feet downstream of the

dam is a house built in the floodplain about three feet above the stream, which would experience significantly more damage. There are several more houses in the next 1.4 miles which would experience varying degrees of damage. At that point, the valley narrows and there are 3 to 5 houses which would be severely damaged in the event of failure or high flows in Allegheny Creek. About 3.3 miles below the dam, Allegheny Creek enters the Schuylkill River.

3.2 Evaluation.

In summary, the visual survey of the dam disclosed no evidence of incipient failure, but the condition of the embankment is judged as poor, because of the extensive vegetation on all exposed portions of the embankment and because the crest of the dam is significantly below design elevation. Seepage noted at the left end of the embankment is assessed to represent a stable condition.

The concrete spillway weir and right spillway wall are judged to be in good condition. However, the left spillway wall is considered to be in poor condition, with cracks and deteriorating concrete. It is concluded that the left spillway wall should be evaluated by a structural engineer to assess the need for repairs.

SECTION 4
OPERATIONAL PROCEDURES

4.1 Procedures.

Normal conditions do not require a dam tender. All flow is discharged over the spillway, and the outlet pipes are normally closed. It is unknown if a minimum downstream flow is required.

4.2 Maintenance of the Dam.

There is no evidence of routine maintenance of this structure. The embankment is covered with thick underbrush and trees up to 10 and 12 inches in diameter, and the crest is uneven.

4.3 Maintenance of Operating Facilities.

Similar to dam maintenance, there is no evidence indicating routine maintenance of the operating facilities. There is no evidence that the valves are operational.

4.4 Warning Systems In Effect.

There are no formal warning systems or procedures established to be followed during periods of exceedingly heavy rainfall.

4.5 Evaluation.

It is judged that the current operating procedure, which does not require a dam tender, is a realistic means of operating the relatively simple control facilities of Green Hills Dam.

In conclusion, it is noted that formal operational, maintenance and warning procedures should be developed and implemented. It should be noted that these procedures should include an inspection checklist, which would include a listing of items to be checked during each inspection and repaired as necessary to insure proper performance of the structure.

SECTION 5
HYDROLOGY/HYDRAULICS

5.1 Evaluation of Features.

a. Design/Evaluation Data. There are no original design data or subsequent evaluation data available for review for this dam. Hydrologic and hydraulic evaluations made as a part of this investigation are contained in Appendix D.

The watershed is about 5.3 miles long and ranges from 1 to 3.5 miles wide, having a total area of 14.5 square miles. Elevations range from a high of 998 in the upper reaches to 297 at normal pool elevation. The watershed is between 40 and 50 percent wooded, with the rest predominantly open/farmland. Less than ten percent of the area of the watershed contains residential development. Residential development can be expected to continue slowly throughout the watershed.

In accordance with criteria established by Federal (OCE) Guidelines, the recommended spillway design flood for this "Small" size dam and "High" hazard potential classification is one-half to the full PMF (Probable Maximum Flood). Because of the small estimated capacity of the reservoir and the scattered development along the creek, the selected spillway design flood is one-half the PMF.

b. Experience Data. No reservoir level records are maintained. The maximum known reservoir level is reported to be 18 inches above the spillway, during Hurricane Agnes, June 1972, corresponding to a peak spillway discharge of 1,030 cfs.

c. Visual Observations. On the date of the inspection, there were no conditions observed that might indicate a possible reduction in spillway capacity during an extreme event. Other observations regarding the condition of the downstream channel, spillway and reservoir are presented in Appendix A, and are discussed in greater detail in Section 3.

d. Overtopping Potential. The overtopping potential of this dam was estimated using the "HEC-1, Dam Safety Version", computer program. A brief description of the program is included in Appendix D. Calculations indicate that the maximum spillway capacity is about 5,370 cfs when the reservoir level is at the minimum embankment crest elevation. The HEC-1 computed peak PMF inflow is about 19,100 cfs. The one-half PMF inflow is about 9,550 cfs. The spillway passes about 28 percent of the PMF without overtopping the dam under

existing conditions. If the crest of the embankment was raised to the design elevation, the dam would be capable of discharging about 35 percent of the PMF without overtopping the dam.

e. Spillway Adequacy. The spillway is rated as "Inadequate" but not "Seriously Inadequate" if some but not all of the following criteria are met:

1. The spillway will not pass 0.5 PMF without overtopping the dam.

2. Overtopping by 0.5 PMF will cause dam failure.

3. There will be a significant increase in property damage and potential for loss of life as a result of failure by overtopping.

The overtopping potential is discussed in the above paragraph. The embankment is assessed to fail if overtopped by one-half foot for more than one hour. The increase in hazard is discussed in the following paragraph.

f. Downstream Conditions. About 1,300 feet below the dam, located on the flood plain, is what appears to be a campsite consisting of a truck trailer and a permanent pavilion. The site would be flooded in the event of large flows in the stream, and would not be expected to be occupied during any significant rainstorm. About 3,400 feet downstream of the dam is the first major damage center, where a house is located about three feet above the stream elevation. Failure during 0.4 PMF is estimated to increase the depth of flow by about 0.9 foot. There are several houses in the next 1.4 miles where, as shown on Plate 1, the valley narrows. There are three to five more houses below this point which would be damaged in the event of dam failure or high flows in the creek. Flow in Allegheny Creek during the 0.4 PMF is estimated to partially flood the lowest level of two of the houses, and failure during 0.4 PMF is estimated to increase the maximum stage by about 0.5 foot. It is not estimated that failure during passage of 0.4 PMF would significantly increase the downstream damage. Therefore, an "Inadequate" spillway classification is warranted.

SECTION 6
STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability.

a. Visual Observations. Visual observations indicated no evidence of existing of pending embankment or spillway instability other than that which would result from overtopping or possibly from decaying root masses. The upstream slope above the waterline, the crest and the downstream slope are covered with heavy underbrush and trees up to 10 to 12 inches in diameter. The embankment is considered to be in poor condition because of this vegetative cover.

The concrete weir and right spillway retaining wall are considered to be in good condition. The left spillway retaining wall is considered to be in poor condition, with deteriorating concrete both at the downstream toe of the wall and on the upstream top of the wall. Also, a vertical crack extends completely through the concrete from the top to below the water level on the upstream side of the wall, and two other major cracks were observed. The left spillway wall appears to be in a stable condition, however. Therefore, the entire spillway is assessed to be in fair condition. The spillway discharges into the relocated stream channel immediately below the spillway apron. The relocated channel has taken on the characteristics of a natural stream, with bank undercutting and meandering, and is considered to be in good condition.

Seepage noted at the left end of the dam is assessed to be in a stable condition. Although seepage under or through the embankment cannot be ruled out, it is judged that at least a considerable portion of the seepage is a result of hillside seepage.

b. Design and Construction Data. No design or construction data are known to exist, other than the plans and specifications. All data concerning physical features of the dam were obtained from the original design drawings and supplemented by visual observations.

c. Operating Procedures. No operating procedures currently exist.

d. Post-Construction Changes. There have been no records nor is there any evidence of any post-construction changes made to this dam or its appurtenances.

e. Embankment Stability. There were no embankment stability evaluations located in the files. Based on the visual observation, the dam appears to be stable at the present time, provided overtopping does not occur and seepage does not occur in the future due to decaying tree roots.

f. Seismic Stability. The dam is located in Seismic Zone 1. Normally it can be considered that if a dam in this zone is stable under static loading conditions, it can be assumed safe for any expected earthquake conditions. Since the dam is qualitatively assessed to be stable at the present time under static loading conditions, it can also reasonably be considered to be stable under seismic loading conditions.

SECTION 7
ASSESSMENT/REMEDIAL MEASURES

7.1 Dam Assessment.

a. Evaluation. Visual inspection indicates that the embankment of Green Hills Dam is in poor condition, and the spillway structure is in fair condition. The overall rating of the dam is considered to be poor.

In accordance with criteria established by Federal (OCE) Guidelines, the recommended spillway design flood for this "Small" size dam and "High" hazard potential classification is one-half to the full Probable Maximum Flood (PMF). Because of the small estimated capacity of the reservoir and the scattered development along the creek, the selected spillway design flood is one-half the PMF.

Hydrologic and hydraulic computations presented in Appendix D indicate that the spillway structure is capable of discharging about 28 percent of the PMF without overtopping the dam under existing conditions. If the crest of the embankment was raised to the original design elevation, the dam would be capable of discharging about 35 percent of the PMF without overtopping. Although one-half the PMF is estimated to cause failure of the embankment by overtopping, the increase in downstream hazard potential is not considered significant. Therefore, the structure is considered to have an "Inadequate" but not "Seriously Inadequate" spillway.

b. Adequacy of Information. The combined visual inspection and simplified calculations presented in Appendix D were sufficient to indicate that further investigations are required for this structure.

c. Urgency. It is recommended that the measures presented in Section 7.2 be implemented as specified.

7.2 Remedial Measures.

a. Facilities. It is recommended that the following measures be undertaken immediately. All work should be performed under the supervision of a registered professional engineer experienced in the design and construction of dams.

1. A hydrologic/hydraulic study should be made to determine the best method of increasing the spillway capacity to meet current hydrologic/hydraulic criteria.

2. All trees on both the upstream and downstream slopes of the embankment should be removed. However, the long-term stability of the slope should be evaluated in the light of decaying root systems.

3. The crest elevation should be increased to meet the original design elevation.

4. The left spillway retaining wall should be evaluated and repaired.

5. The controls for the 8 and 36 inch conduits should be made operational.

6. The seepage noted downstream of the embankment should be monitored on a regular basis. Any significant increase in seepage amount or development of turbidity should be evaluated by a registered professional engineer experienced in the design and construction of dams.

b. Operation and Maintenance Procedures. Because of the location of the dam and the potential for heavy property damage and possible loss of life in the event of high flows or failure, a formal procedure of observation and warning during periods of high precipitation should be developed and implemented for this facility. This procedure should include a method of warning downstream residents that high flows are to be expected. In addition, an operation and maintenance procedure should also be developed to insure that all pertinent items are carefully inspected on a regular basis and maintained in the best possible condition.

APPENDIX

A

CHECK LIST
VISUAL INSPECTION
PHASE I

Name Dam *Green Hills Dam* County *Berks* State *Pennsylvania* National ID # *PA 00714*

Type of Dam *Earth* Hazard Category *High*

Date(s) Inspection *11/28/1979* Weather *Partly sunny* Temperature *50's*

Pool Elevation at Time of Inspection *297.0* M.S.L. Tailwater at Time of Inspection *—* M.S.L.

Inspection Personnel:

Mary F. Beck (Hydrologist)
Arthur H. Dvinoff (Geotechnical/Civil)
Raymond S. Lambert (Geologist)
Vincent McKeever (Hydrologist)
John H. Frederick, Jr. (4/8/1980)

Mary F. Beck Recorder

Remarks:

The Owner was not present during the inspection of the dam.

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
ANY NOTICEABLE SEEPAGE	*N/A*	
STRUCTURE TO ABUTMENT/EMBANKMENT JUNCTIONS	*N/A*	
DRAINS	*N/A*	
WATER PASSAGES	*N/A*	
FOUNDATION	*N/A*	

CONCRETE/MASONRY DAMS

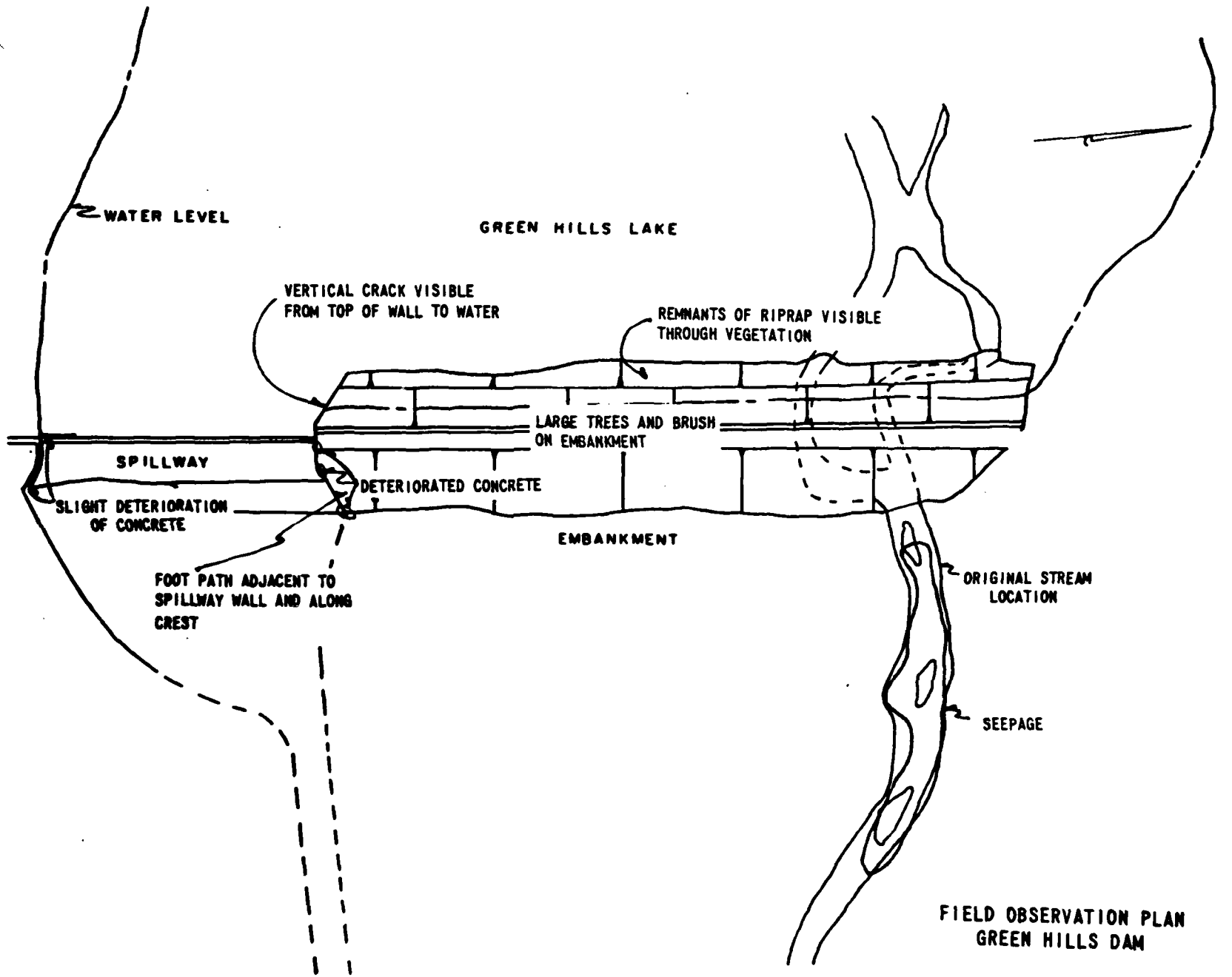
VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS CONCRETE SURFACES	*N/A*	
STRUCTURAL CRACKING	*N/A*	
VERTICAL AND HORIZONTAL ALIGNMENT	*N/A*	
MONOLITH JOINTS	*N/A*	
CONSTRUCTION JOINTS	*N/A*	

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	*None observed.*	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	*None observed.*	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	*Waves have damaged some portions of upstream embankments; generally heavy brush and tree growth have protected slope from waves. A foot traffic path has damaged the crest and slope near the spillway.*	
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	*Horizontal alignment could not be observed due to heavy vegetation. The vertical alignment is shown on Sheet 5B.*	
RIPRAP FAILURES	*Heavy underbrush and trees are growing through paving above the waterline.*	

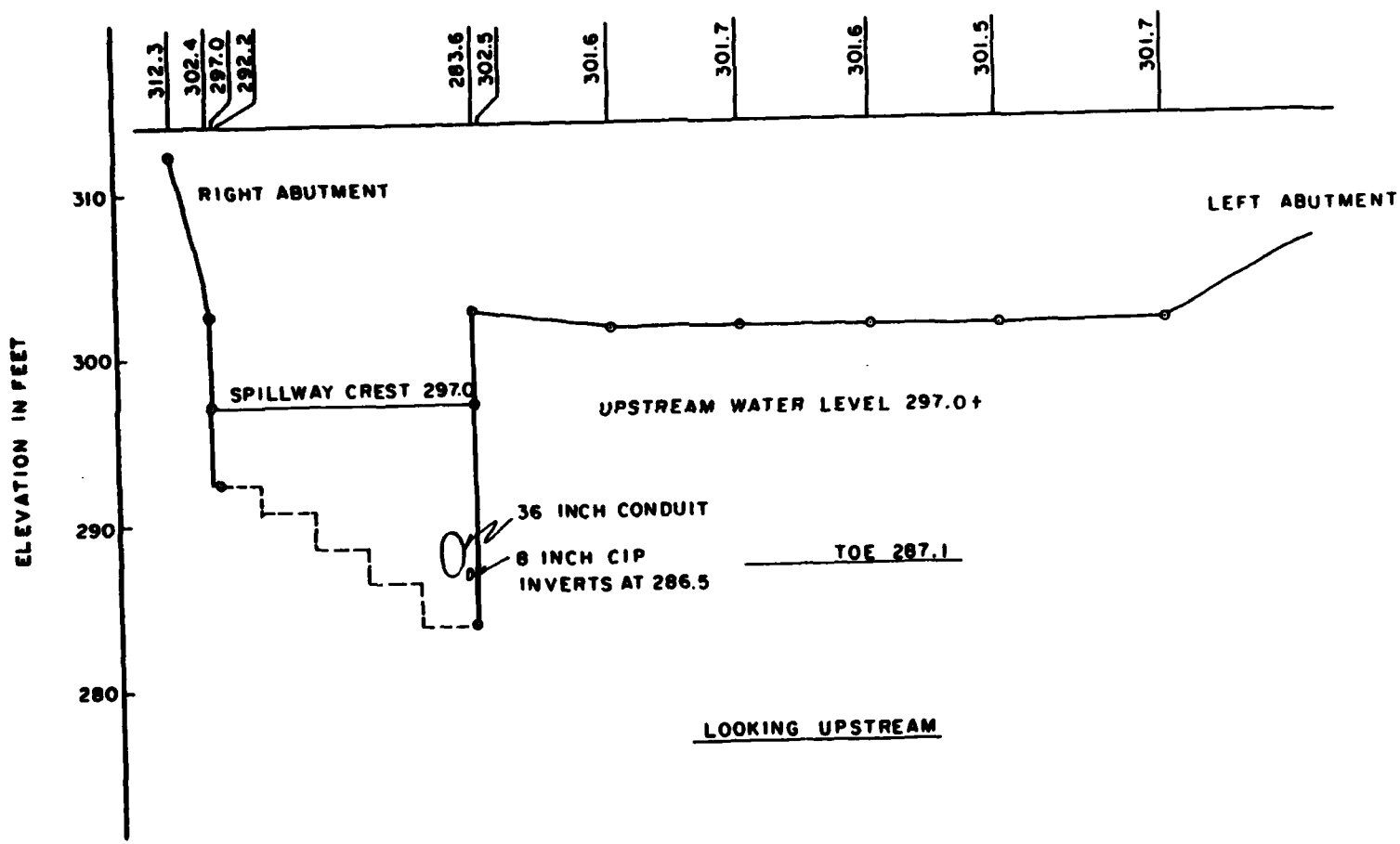
EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
VEGETATION	*Upstream and downstream slopes and crest are thickly vegetated with trees up to 12 inches in diameter; see Photograph No. 5.*	
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	*All junctions appear to be in good condition.*	
ANY NOTICEABLE SEEPAGE	*Yes, see Sheet 5a.*	
STAFF GAGE AND RECORDER	*None*	
DRAINS	*None located.*	



FIELD OBSERVATION PLAN
GREEN HILLS DAM

SHEET 5A OF 11



FIELD OBSERVATION PROFILE
GREEN HILLS DAM

SHEET 5B OF 11

OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	*N/A, outlet works consist of an 8-inch CIP and 36-inch steel pipe. The end of the 8-inch pipe is cracked.*	
INTAKE STRUCTURE	*Intake under water.*	
OUTLET STRUCTURE	*N/A*	
OUTLET CHANNEL	*Both pipes outlet through weir.*	
EMERGENCY GATE	*What appears to be a valve stem can be seen under water. An empty bracket is attached to left spillway wall upstream of weir. Gate was not exercised.*	

UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	*The ogee weir is in fairly good condition. The crest of the weir is level and water was flowing over uniformly. The crest of the far right section (see Photograph 10) has some spalling. Concrete surfaces are rough.*	
SPILLWAY WALLS	*The right spillway wall appears in good condition with no significant cracking, concrete deterioration or movement. The left spillway wall appears to be stable; however, in three locations, one downstream and two upstream of the weir, vertical cracks through the wall extend from the top to the water or floor. The downstream end of the wall is deteriorating. Concrete is spalling off top of wall and apparently had been repaired once in the past at that location.*	
DISCHARGE CHANNEL	*The channel downstream of the weir appears in good condition with expected bank undercutting (rock) occurring on outside bends. Large trees are lying in the channel.*	
BRIDGE AND PIERS	*None*	

GATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE SILL	*N/A*	
APPROACH CHANNEL	*N/A*	
DISCHARGE CHANNEL	*N/A*	
BRIDGE AND PIERS	*N/A*	
GATES AND OPERATION EQUIPMENT	*N/A*	

INSTRUMENTATION

VISUAL EXAMINATION	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	*None*	
OBSERVATION WELLS	*None*	
WEIRS	*None*	
PIEZOMETERS	*None*	
OTHER	*None*	

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	*The reservoir slopes are flat to moderate. The area immediately around the reservoir is about 35 percent open land and the rest is wooded with homes.*	
SEDIMENTATION	*Considerable sedimentation at upper end, has reduced normal pool surface area and normal storage capacity.*	

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	*The stream is about 40 feet wide with low banks. The flood plain is fairly wide below the dam with thick underbrush.*	
SLOPES	*The valley gradient is about 0.007.*	
APPROXIMATE NO. OF HOMES AND POPULATION	*The first downstream house is about 2,000 feet below the dam and would experience some damage in the event of failure. About 2,000 feet further downstream is another house about 3 feet above the stream which would experience significantly more damage. There are several more houses in the next 1.4 miles which would experience varying degrees of damage. At that point, the valley narrows and there are 3 to 5 houses which would be severely damaged in the event of failure or high flows in Allegheny Creek.*	

APPENDIX

B

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

NAME OF DAM *Green Hills Dam*

ID # *PA 00714*

ITEM	REMARKS
AS-BUILT DRAWINGS	*None available.*
REGIONAL VICINITY MAP	*See Plate 1, Appendix E.*
CONSTRUCTION HISTORY	*Unknown.*
TYPICAL SECTIONS OF DAM	*See Appendix E.*
OUTLETS - PLAN	*Appendix E.*
DETAILS	
CONSTRAINTS	
DISCHARGE RATINGS	*See Appendix D.*
RAINFALL/RESERVOIR RECORDS	*None*

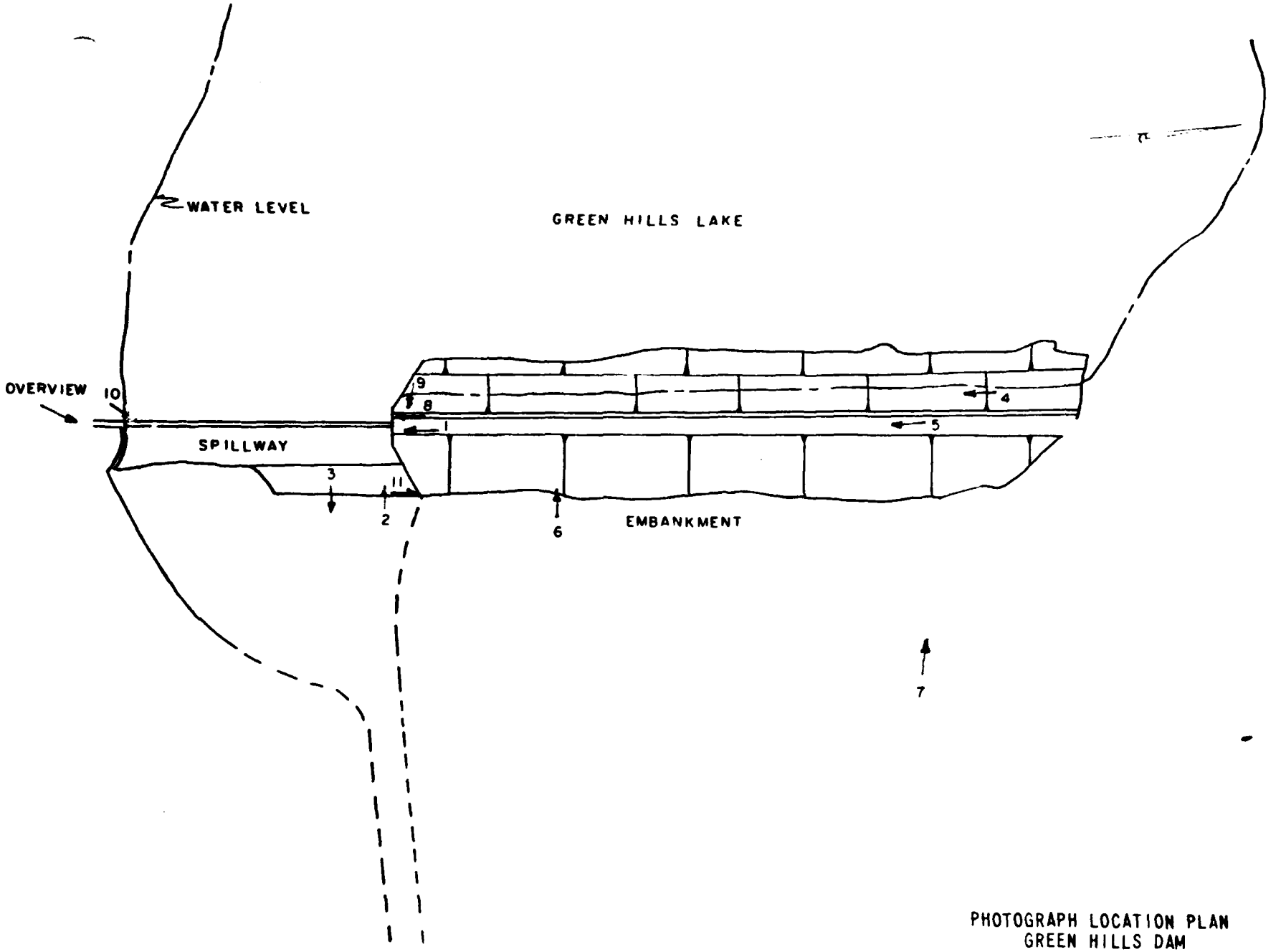
ITEM	REMARKS
DESIGN REPORTS	*None known.*
GEOLOGY REPORTS	*See Appendix F.*
DESIGN COMPUTATIONS	*Unknown*
HYDROLOGY & HYDRAULICS	*See Appendix D.*
DAM STABILITY	*Stability analysis of spillway section only.*
SEEPAGE STUDIES	*Stability analysis of spillway section only.*
MATERIALS INVESTIGATIONS	
BORING RECORDS	
LABORATORY	*Unknown.*
FIELD	
POST-CONSTRUCTION SURVEYS OF DAM	*Unknown.*
BORROW SOURCES	*Unknown.*

ITEM	REMARKS
MONITORING SYSTEMS	*None*
MODIFICATIONS	*None known.*
HIGH POOL RECORDS	*Limited, see Section 5.*
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	*None known.*
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	*None known.*
MAINTENANCE OPERATION RECORDS	*None*

ITEM	REMARKS
SPILLWAY PLAN SECTIONS DETAILS	*See Appendix E.*
OPERATING EQUIPMENT PLANS & DETAILS	*No information available.*
MISCELLANEOUS	*1. Design drawings were available from DER files.* *2. Construction specification.* *3. Conversation with Owner.*

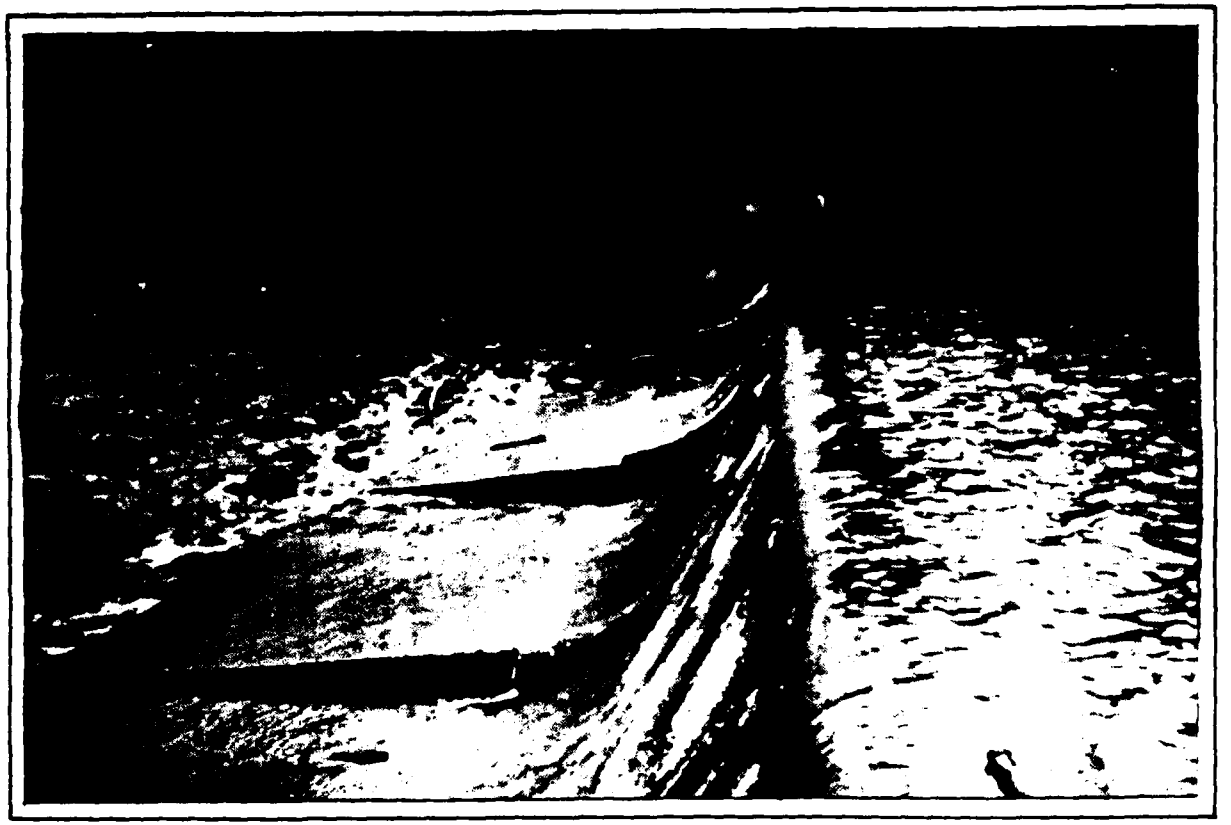
APPENDIX

C



PHOTOGRAPH LOCATION PLAN
GREEN HILLS DAM

PLATE C-1

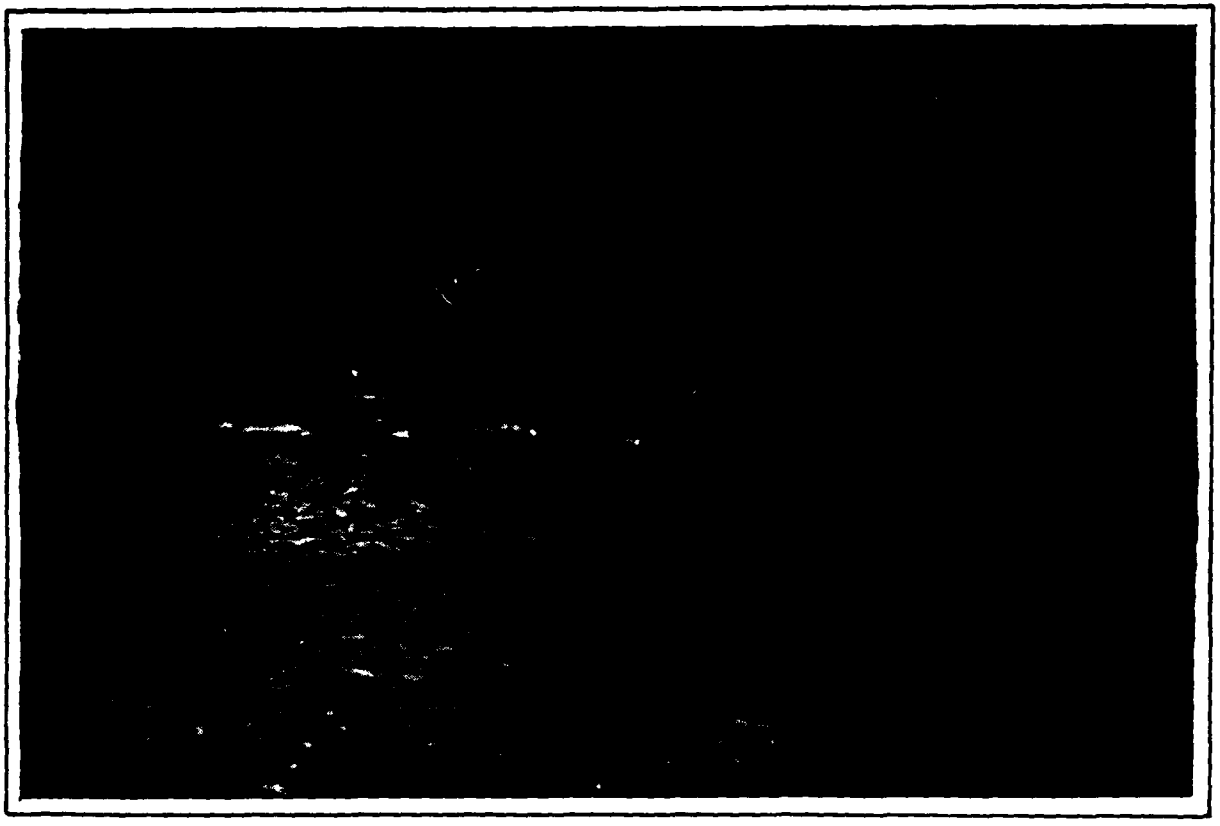


SPILLWAY CREST VIEWED FROM EMBANKMENT.

PHOTOGRAPH NO. 1

THREE FOOT AND 8 INCH
DIAMETER PIPES AT LEFT
END OF SPILLWAY.

PHOTOGRAPH NO. 2



ALLEGHENY CREEK IMMEDIATELY BELOW
THE DAM.

PHOTOGRAPH NO. 3

VIEW OF UPSTREAM SLOPE.

PHOTOGRAPH NO. 4

EMBANKMENT CREST.

PHTOGRAPH NO. 5

TYPICAL VIEW OF DOWNSTREAM
SLOPE.

PHOTOGRAPH NO. 6

SEEPAGE AT LEFT END OF DAM.

PHOTOGRAPH NO. 7

BRACKET ATTACHED TO LEFT SPILLWAY WALL. CRACK EXTENDS TO BELOW WATERLINE.

PHOTOGRAPH NO. 8

DETERIORATING CONCRETE OF LEFT SPILLWAY WALL, LOCATED ABOVE BRACKET SHOWN IN PHOTOGRAPH NO. 8.

PHOTOGRAPH NO. 9

MINOR SPALLING OF SPILLWAY CREST
NEAR RIGHT WALL.

PHOTOGRAPH NO. 10

DETERIORATING CONCRETE AT DOWNSTREAM END
OF LEFT SPILLWAY WALL.

PHOTOGRAPH NO. 11

CAMP SITE LOCATED DOWNSTREAM OF DAM.

PHOTOGRAPH NO. 12

DOWNSTREAM HOUSE BUILT IN FLOOD PLAIN.

PHOTOGRAPH NO. 13

APPENDIX

D

GREEN HILLS DAM
CHECK LIST
HYDROLOGIC AND HYDRAULIC
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: *50% wooded, about 10% residential development.*

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): *297.0 feet (104 Acre-Feet est.).*

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): *301.5 feet (241 Acre-Feet est.*

ELEVATION MAXIMUM DESIGN POOL: ----

ELEVATION TOP DAM: *301.5 feet.*

SPILLWAY

a. Elevation *297*

b. Type *Concrete weir.*

c. Width *160 feet.*

d. Length -----

e. Location Spillover *Right abutment.*

f. Number and Type of Gates *None*

OUTLET WORKS:

a. Type *36 inch steel and 8 inch CI conduits.*

b. Location *Through weir near left spillway wall.*

c. Entrance inverts *Unknown.*

d. Exit inverts *284.5 feet.*

e. Emergency draindown facilities *The outlet works.*

HYDROMETEOROLOGICAL GAGES:

a. Type *None.*

b. Location ---

c. Records ---

MAXIMUM NON-DAMAGING DISCHARGE: *Not determined.*

DRAINAGE AREA:(1) *14.6 square miles.*

PROBABLE MAXIMUM PRECIPITATION (PMP)
FOR 10 SQ. MILES IN 24 HOURS:(2) *23.2 inches*

ADJUSTMENT FACTORS FOR DRAINAGE AREA (%):(3)

Zone *6*

6 Hours *108 %*

12 Hours *118 %*

24 Hours *127 %*

48 Hours *138 %*

SNYDER HYDROGRAPH PARAMETERS:(4)

Zone *6*

C_p, C_t *0.40, 1.35*

L(5) *7.67 miles*

Lca (6) *3.27 miles*

$tp = C_t (L\ Lca)^{0.3}$ *3.55*

SPILLWAY CAPACITY AT MAXIMUM
WATER LEVEL(7) *5370 cfs.*

---

(1) Measured from USGS maps.
(2) Hydrometerological Report No. 33, Figure 1.
(3) Hydrometerological Report No. 33, Figure 2.
(4) Information received from Corps of Engineers, Baltimore District.
(5) Length of longest water course from outlet to basin divide, measured from USGS maps.
(6) Length of water course from outlet to point opposite the centroid of drainage area, (see Plate 1, Appendix E) measured from USGS maps.
(7) See Sheet *4,12* of this Appendix.

HEC-1, REVISED
FLOOD HYDROGRAPH PACKAGE

The original "Flood Hydrograph Package" (HEC-1), developed by the Hydrologic Engineering Center, Corps of Engineers, has been modified for use under the National Dam Inspection Program. The "Flood Hydrograph Package (HEC-1), Dam Safety Version", hereinafter referred to as, HEC-1, Rev., has been modified to require less detailed input and to include a dam breach analysis. The required input is obtained from the field inspection of a dam, any available design/evaluation data, relatively simple hydraulic calculations, or information from the USGS Quandrangle maps. The input format is flexible in order to reflect any unique characteristics of an individual dam.

HEC-1, Rev. computes a reservoir inflow hydrograph based on individual watershed characteristics such as: area, percentage of impervious surface area, watershed shape, and hydrograph characteristics determined from regional correlation studies by the Corps of Engineers, Baltimore District. The inflow is routed through the reservoir using spillway discharge data obtained from the field inspection or design data. Flood storage capacity is determined from USGS maps or design information and verified by the field inspection. In the event a spillway cannot discharge 0.5 PMF without overtopping and failure of the dam, downstream channel characteristics obtained from the field inspection and USGS maps are inputed and flows are routed downstream to the damage center and a dam breach analysis is performed.

Included in this Appendix are the HEC-1, Rev. pertinent input values and a summary print-out tables.

BY MEB DATE 4/8/80 SUBJECT Green Hills Dam Hydrology / Hydraulics SHEET 4 OF 14

CKD. BY AHD DATE 4/8/80 JOB No.

Classification (Ref- Recommended Guidelines for Safety Inspection of Dams)

1. The hazard classification is "High" as there would be probable loss of life in the event of failure.

2. The size classification is "Small" based on its estimated total capacity of 241 Ac-Ft.

3. The selected spillway design flood, based on size and hazard classification is 0.5 PMF (Probable Maximum Flood).

Hydrology and Hydraulic Analysis

1. Original Design Data - No data was available other than estimated normal pool surface area of 31.5 Ac and 61 mgal capacity.

2. Evaluation Data

Inflow hydrograph parameters are shown on sheet 2.

Outflow hydrograph.

Elevation - Area Data - obtained from current USGS maps was used to compute normal and flood storage, see sheet 8. Sedimentation at upper end has reduced normal pool area to 23.9 Ac.

Elevation - Discharge Data -

$Q = CLH^{3/2}$

L = 160 ft - design drawing; verified by inspection

C = 3.5 ref- King & Brater, Handbk of Hydraulics, 6ed, 1976 Fig 5-17, assume constant C

Water Surface	H	C	L	Q	
297	0	3.5	160	0	
298	1			560 cfs	✓
299	2			1584	✓
300	3			2910	✓
301	4			4480	✓
303	6			8230	✓
307	10			17710	✓

BY MFB DATE 4/8/80 Rev. 4/30/80 SUBJECT Green Hills Dam Hydrology / Hydraulics SHEET 5 OF 14

CKD. BY DATE JOB No.

3. Spillway Adequacy

- The spillway does not pass 0.5 PMF without overtopping the embankment - sheet 12

- The embankment is assessed to fail by overtopping during the 0.5 PMF - sheet 13

- The maximum increase in downstream water level occurs during the 0.4 PMF event. Increases are about 0.9 ft & 0.7 ft at sections 3400 ft and 2 miles downstream of the dam respectively, and it is judged the downstream damage potential is not significantly increased.

Therefore, the spillway is rated as "Inadequate" but not "Seriously Inadequate".

PREVIEW OF SEQUENCE OF STREAM NETWORK CALCULATIONS

RUNOFF HYDROGRAPH AT	IN
ROUTE HYDROGRAPH TO	OUT
ROUTE HYDROGRAPH TO	DS1
ROUTE HYDROGRAPH TO	DS2
END OF NETWORK	

1**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION JULY 1978
LAST MODIFICATION 26 FEB 79
****

RUN DATE= 80/04/04.
TIME= 05.14.15.

GREEN HILLS DAM
NAT ID NO. PA 00714 DER NO. 6-373
OVERTOPPING ANALYSIS

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
200	0	15	0	0	0	0	0	-4	0

JOPER	NUT	LROPT	TRACE
5	0	0	0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 5 LRTIO= 1
RTIOS= .25 .30 .40 .50 1.00

SHEET 6 OF 14

SUB-AREA RUNOFF COMPUTATION

INFLOW HYDROGRAPH

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
IN	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	14.60	0.00	14.60	0.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	23.20	108.00	118.00	127.00	138.00	0.00	0.00

TRSPC COMPUTED BY THE PROGRAM IS .813

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	1.00	.05	0.00	0.00

UNIT HYDROGRAPH DATA

TP= 3.55 CP= .40 NTA= 0

RECESSION DATA

STRTQ= -1.50 QRCSN= -.05 RTIOR= 2.00

UNIT HYDROGRAPH100 END-OF-PERIOD ORDINATES, LAG= 3.58 HOURS, CP= .40 VOL= .97

18.	67.	139.	225.	323.	430.	544.	662.	773.	870.
952.	1017.	1065.	1092.	1088.	1056.	1016.	979.	942.	907.
874.	841.	810.	780.	751.	723.	696.	670.	645.	621.
598.	576.	554.	534.	514.	495.	477.	459.	442.	425.
410.	394.	380.	366.	352.	339.	326.	314.	302.	291.
280.	270.	260.	250.	241.	232.	223.	215.	207.	199.
192.	185.	178.	171.	165.	159.	153.	147.	142.	137.
131.	127.	122.	117.	113.	109.	105.	101.	97.	93.
90.	87.	83.	80.	77.	74.	72.	69.	66.	64.
62.	59.	57.	55.	53.	51.	49.	47.	46.	44.

0 END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q

SUM	26.03	23.61	2.42	668148.
	(661.)	(600.)	(61.)	(18919.84)

SHEET 7 OF 14

HYDROGRAPH ROUTING

OUTFLOW HYDROGRAPH

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
OUT	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-297.	-1

STAGE	297.00	298.00	299.00	300.00	301.00	302.00	303.00	307.00
FLOW	0.00	560.00	1584.00	2910.00	4480.00	6260.00	8230.00	17710.00
SURFACE AREA=	0.	24.	33.	107.				
CAPACITY=	0.	104.	189.	1515.				
ELEVATION=	284.	297.	300.	320.				

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
297.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
301.5	0.0	0.0	0.

CREST LENGTH AT OR BELOW ELEVATION	0.	340.	450.	500.
	301.5	301.7	302.5	307.0

SHEET 8 OF 14

HYDROGRAPH ROUTING

SECTION 425 FEET DOWNSTREAM OF DAM

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
DS1	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	0.	0

NORMAL DEPTH CHANNEL ROUTING

QN(1)	QN(2)	QN(3)	ELNVT	ELMAX	RLNTH	SEL
.0700	.0400	.0700	280.0	300.0	425.	.00600

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC

0.00 300.00 72.00 282.00 102.00 282.00 102.00 280.00 140.00 280.00
140.00 282.00 462.00 282.00 534.00 300.00

STORAGE	0.00	.39	1.14	5.20	9.34	13.57	17.89	22.29	26.78	31.36
	36.02	40.77	45.61	50.53	55.54	60.63	65.81	71.08	76.44	81.88
OUTFLOW	0.00	115.21	368.32	1441.25	3321.29	5853.36	8969.55	12628.87	16803.46	21473.17
	26622.79	32240.57	38317.24	44845.47	51819.35	59234.17	67086.16	75372.34	84090.37	93238.46
STAGE	280.00	281.05	282.11	283.16	284.21	285.26	286.32	287.37	288.42	289.47
	290.53	291.58	292.63	293.68	294.74	295.79	296.84	297.89	298.95	300.00
FLOW	0.00	115.21	368.32	1441.25	3321.29	5853.36	8969.55	12628.87	16803.46	21473.17
	26622.79	32240.57	38317.24	44845.47	51819.35	59234.17	67086.16	75372.34	84090.37	93238.46

SHEET 9 OF 14

HYDROGRAPH ROUTING

SECTION AT FIRST DOWNSTREAM HOUSE

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
DS2	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPKAT
1	0	0	0.000	0.000	0.000	0.	0

NORMAL DEPTH CHANNEL ROUTING

QN(1)	QN(2)	QN(3)	ELMVT	ELMAX	RLNTH	SEL
.0500	.0350	.0600	260.0	280.0	3000.	.00600

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC

0.00 280.00 137.00 263.20 217.00 263.40 217.00 260.00 240.00 260.00
240.00 266.60 292.00 266.40 400.00 280.00

STORAGE	0.00	1.67	3.33	5.00	11.97	20.35	29.35	42.33	57.21	73.31
	90.64	109.19	128.98	149.99	172.24	195.71	220.41	246.33	273.49	301.87
OUTFLOW	0.00	77.93	234.47	438.53	850.46	1571.48	2538.46	3842.14	5545.12	7612.96
	10044.71	12845.94	16025.08	19592.04	23557.59	27932.95	32729.66	37959.37	43633.82	49764.77
STAGE	260.00	261.05	262.11	263.16	264.21	265.26	266.32	267.37	268.42	269.47
	270.53	271.58	272.63	273.68	274.74	275.79	276.84	277.89	278.95	280.00
FLOW	0.00	77.93	234.47	438.53	850.46	1571.48	2538.46	3842.14	5545.12	7612.96
	10044.71	12845.94	16025.08	19592.04	23557.59	27932.95	32729.66	37959.37	43633.82	49764.77

HYDROGRAPH ROUTING

SECTION TWO MILES BELOW DAM

ISTAW	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
DS3	1	0	0	0	0	1	0	0

ALL PLANS HAVE SAME ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	0.	0

NORMAL DEPTH CHANNEL ROUTING

QN(1)	QN(2)	QN(3)	ELNVT	ELMAX	RLNTH	SEL
.0500	.0350	.0500	232.0	252.0	8000.	.00500

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC

0.00 250.00 25.00 240.00 45.00 235.00 55.00 232.00 95.00 232.00
105.00 235.00 220.00 239.00 270.00 250.00

STORAGE	0.00	8.41	18.18	29.36	45.29	67.89	97.15	132.77	171.15	211.02
	252.32	295.05	339.22	384.82	431.86	480.33	530.23	581.56	633.75	685.95
OUTFLOW	0.00	134.88	442.73	912.38	1626.80	2603.28	3894.14	5583.06	7717.38	10205.06
	13027.16	16175.68	19645.67	23434.18	27539.65	31961.57	36700.18	41756.34	47066.90	53250.00
STAGE	232.00	233.05	234.11	235.16	236.21	237.26	238.32	239.37	240.42	241.47
	242.53	243.58	244.63	245.68	246.74	247.79	248.84	249.89	250.95	252.00
FLOW	0.00	134.88	442.73	912.38	1626.80	2603.28	3894.14	5583.06	7717.38	10205.06
	13027.16	16175.68	19645.67	23434.18	27539.65	31961.57	36700.18	41756.34	47066.90	53250.00

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

Existing Conditions - No Failure

OPERATION	STATION	AREA	PLAN	RATIO 1 .25	RATIO 2 .30	RATIO 3 .40	RATIO 4 .50	RATIO 5 1.00
				RATIOS APPLIED TO FLOWS				
HYDROGRAPH AT	IN	14.60 (37.81)	1	4777. (135.27)(	5732. (162.32)(	7643. (216.43)(	9554. (270.54)(	19108. (541.08)(
ROUTED TO	OUT	14.60 (37.81)	1	4751. (134.53)(	5706. (161.59)(	7628. (215.99)(	9536. (270.03)(	19072. (540.05)(
ROUTED TO	DS1	14.60 (37.81)	1	4749. (134.47)(	5706. (161.57)(	7628. (216.01)(	9538. (270.09)(	19077. (540.19)(
ROUTED TO	DS2	14.60 (37.81)	1	4747. (134.41)(	5699. (161.38)(	7625. (215.92)(	9537. (270.06)(	19086. (540.45)(
ROUTED TO	DS3	14.60 (37.81)	1	4725. (133.79)(	5676. (160.73)(	7596. (215.11)(	9508. (269.23)(	19031. (538.91)(

SUMMARY OF DAM SAFETY ANALYSIS

Existing Conditions - No Failure

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	297.00	297.00	301.50
STORAGE	104.	104.	241.
OUTFLOW	0.	0.	5370.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.25	301.15	0.00	229.	4751.	0.00	43.50	0.00
.30	301.67	.17	248.	5706.	2.00	43.50	0.00
.40	302.33	.83	273.	7628.	5.25	43.50	0.00
.50	302.83	1.33	293.	9536.	7.75	43.50	0.00
1.00	304.63	3.13	372.	19072.	10.50	43.50	0.00

PLAN 1 STATION DS1

425 ft. below dam

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.25	4749.	284.8	43.50
.30	5706.	285.2	43.50
.40	7628.	285.9	43.50
.50	9538.	286.5	43.50
1.00	19077.	288.9	43.50

PLAN 1 STATION DS3

section two miles downstream of dam

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.25	4725.	238.8	44.00
.30	5676.	239.4	44.00
.40	7596.	240.4	43.75
.50	9508.	241.2	43.75
1.00	19031.	244.4	43.75

PLAN 1 STATION DS2

section at first downstream house

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.25	4747.	267.9	43.75
.30	5699.	268.5	43.75
.40	7625.	269.5	43.50
.50	9537.	270.3	43.50
1.00	19086.	273.5	43.50

SUMMARY OF DAM SAFETY ANALYSIS
Existing Conditions - Failure Assumed

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	297.00	297.00	301.50
STORAGE	104.	104.	241.
OUTFLOW	0.	0.	5370.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.25	301.15	0.00	229.	4751.	0.00	43.50	0.00
.30	301.67	.17	248.	5706.	2.00	43.50	0.00
.40	302.33	.83	273.	10386.	2.11	43.75	43.25
.50	302.44	.94	278.	11486.	1.69	42.50	42.00
1.00	303.22	1.72	309.	19072.	7.82	43.50	40.25

DAM BREACH DATA

BRWID	Z	ELBM	TFAIL	WSEL	FAILEL
40.	0.00	287.00	.50	297.00	302.30

PLAN 1 STATION DS1
425 ft. below dam

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.25	4749.	284.8	43.50
.30	5706.	285.2	43.50
.40	10370.	286.7	43.75
.50	11454.	287.0	42.50
1.00	19097.	288.9	43.50

PLAN 1 STATION DS3
section two miles downstream of dam

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.25	4725.	238.8	44.00
.30	5676.	239.4	44.00
.40	9429.	241.1	44.00
.50	10521.	241.6	42.75
1.00	19031.	244.4	43.75

PLAN 1 STATION DS2
section at first downstream house

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.25	4747.	267.9	43.75
.30	5699.	268.5	43.75
.40	9841.	270.4	43.75
.50	10852.	270.8	42.50
1.00	19082.	273.5	43.50

SUMMARY OF DAM SAFETY ANALYSIS

Design Conditions - Failure Assumed

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	297.00	297.00	302.50
STORAGE	104.	104.	280.
OUTFLOW	0.	0.	7245.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.25	301.15	0.00	229.	4751.	0.00	43.50	0.00
.30	301.66	0.00	248.	5663.	0.00	43.75	0.00
.40	302.10	0.00	264.	6453.	0.00	45.25	0.00
.50	302.00	0.00	260.	6255.	0.00	47.25	0.00
1.00	302.26	0.00	270.	6765.	0.00	50.00	0.00

PLAN 1 STATION DS1

425 ft. below the dam

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.25	4749.	284.8	43.50
.30	5666.	285.2	43.50
.40	6506.	285.5	42.50
.50	6255.	285.4	47.25
1.00	6765.	285.6	50.00

PLAN 1 STATION DS2

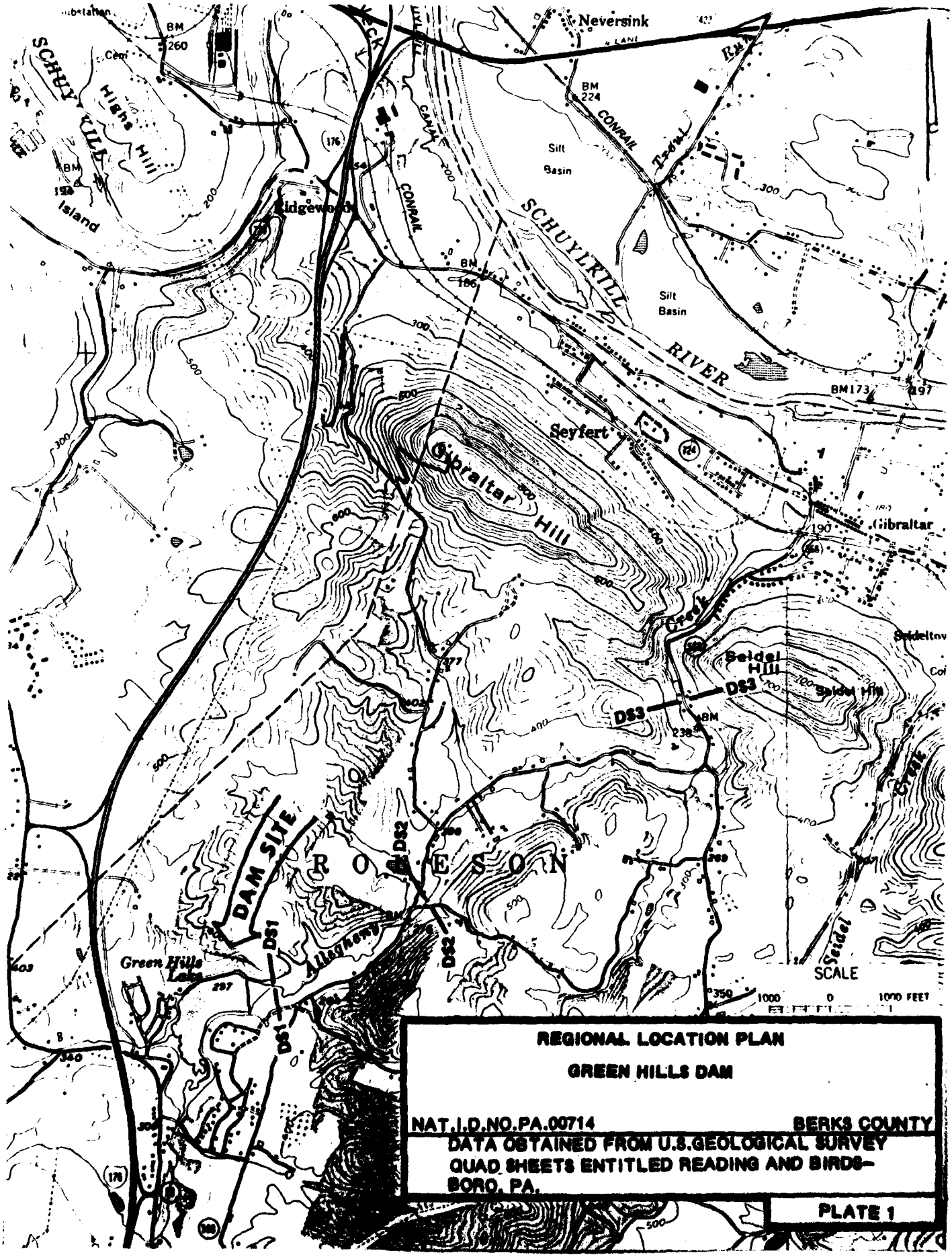
section at first downstream house

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.25	4747.	267.9	43.75
.30	5666.	268.5	43.50
.40	6464.	268.9	42.50
.50	6255.	268.8	47.25
1.00	6764.	269.0	50.00

SHEET 14 OF 14

APPENDIX

E



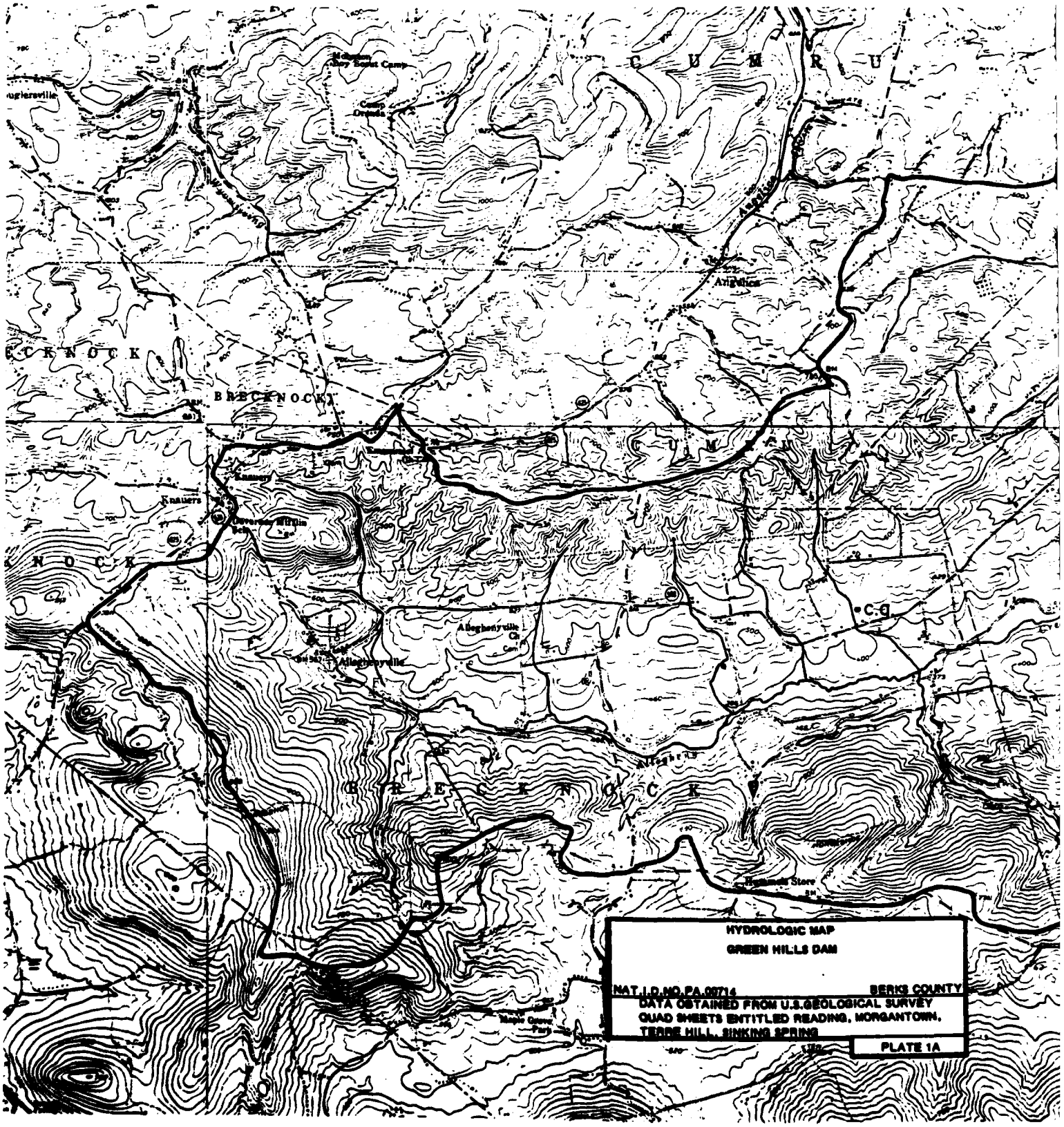
REGIONAL LOCATION PLAN

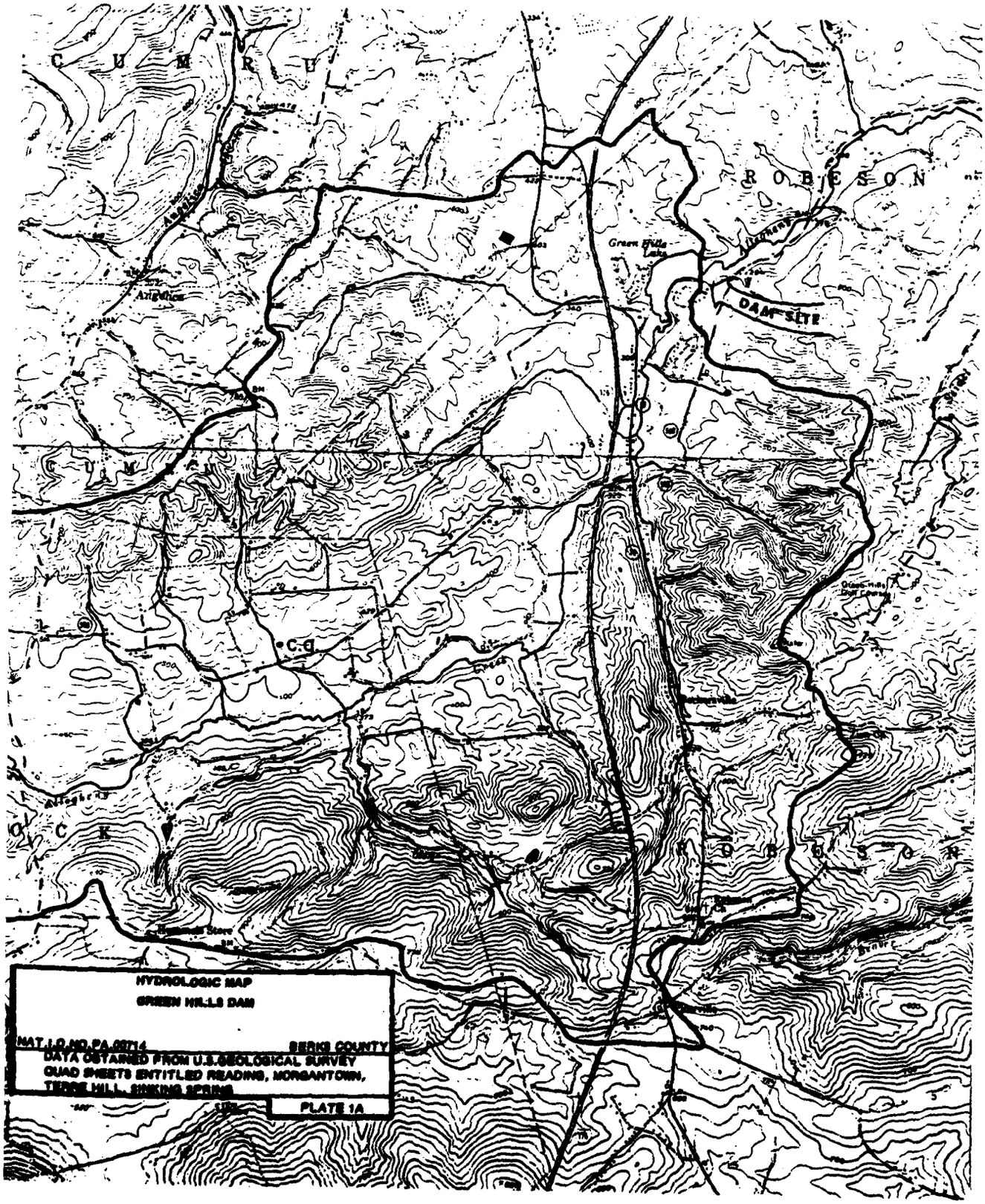
GREEN HILLS DAM

NAT.I.D.NO.PA.00714 BERKS COUNTY

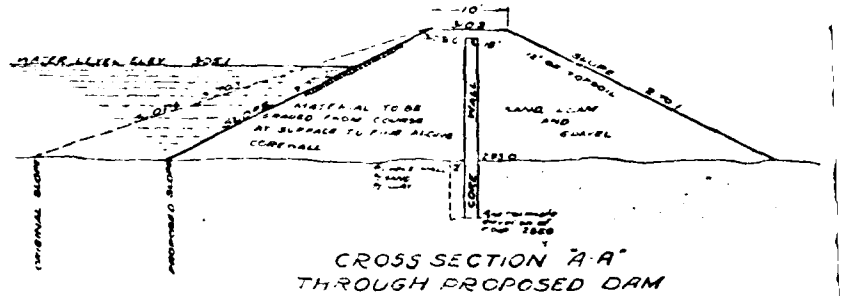
DATA OBTAINED FROM U.S.GEOLOGICAL SURVEY QUAD SHEETS ENTITLED READING AND BIRDSBORO, PA.

PLATE 1

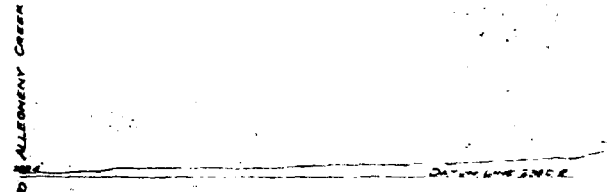

HYDROLOGIC MAP
GREEN HILLS DAM
NAT. I.D.NO.PA 09714
BERKS COUNTY
DATA OBTAINED FROM U.S.GEOLOGICAL SURVEY
QUAD SHEETS ENTITLED READING, MORGANTOWN,
TERRE HILL, SINKING SPRING
PLATE 1A


C U M R U
ROBESON
Green Hills Lake
DAM SITE
C U M
C.G
C C K
ROBESON
HYDROLOGIC MAP
GREEN HILLS DAM
NAT. I.D.NO.PA 08714
BERKS COUNTY
DATA OBTAINED FROM U.S.GEOLOGICAL SURVEY
QUAD SHEETS ENTITLED READING, MORGANTOWN,
TERRE HILL, SINKING SPRING
PLATE 1A

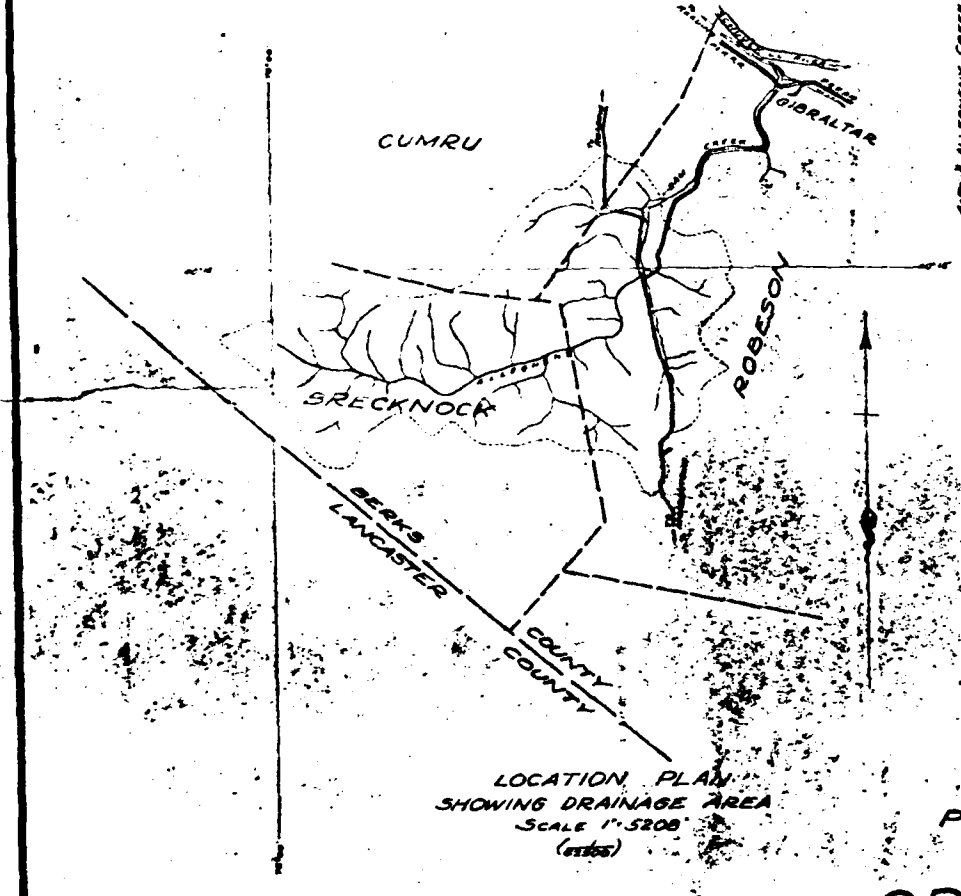
2



CROSS SECTION "A-A"
THROUGH PROPOSED DAM
SCALE - 1" = 10'



PROFILE "B-B"
OF
WASTEWAY CHANNEL
FROM
TOE OF SPILLWAY
TO
ALLEGHENY CREEK
SCALE { HORIZONTAL 1" = 60'
VERTICAL 1" = 10'



LOCATION PLAN
SHOWING DRAINAGE AREA
SCALE 1" = 5200'
(erased)

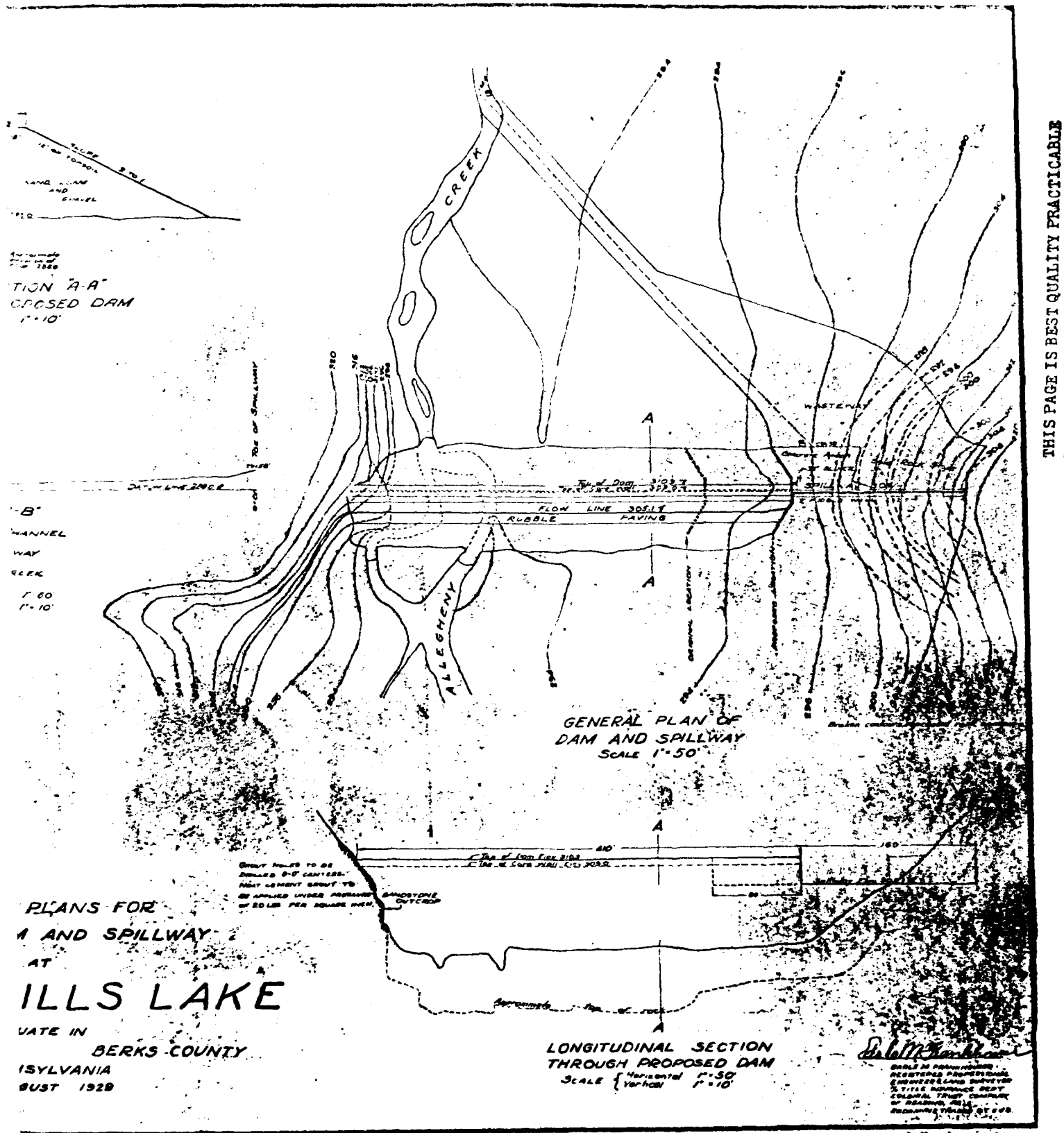
REVISED PLANS FOR PROPOSED DAM AND SPILLWAY AT GREEN HILLS LAKE

SITUATE IN
ROBESON TOWNSHIP BERKS COUNTY
PENNSYLVANIA
AUGUST 1929

NOTE:- THIS PLAN REVISES LOCATION OF SPILLWAY AND SLOPE OF UPSTREAM EMBANKMENT AS SHOWN ON PLANS APPROVED UNDER PERMIT NO 6-373 ISSUED TO BENJAMIN D. GATES, ROBESON TOWNSHIP BERKS COUNTY, PENNSYLVANIA

DETAILS TO REMAIN THE SAME

G-17-D-17A



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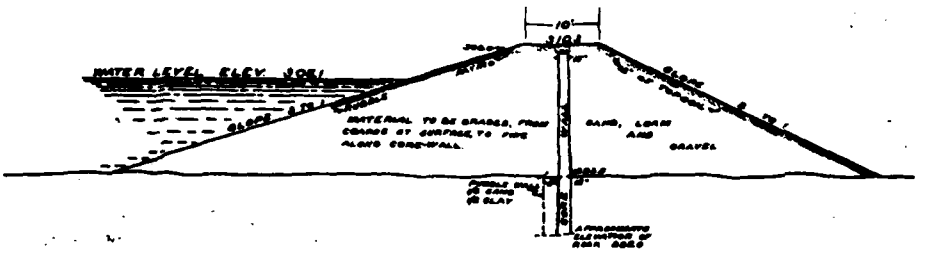
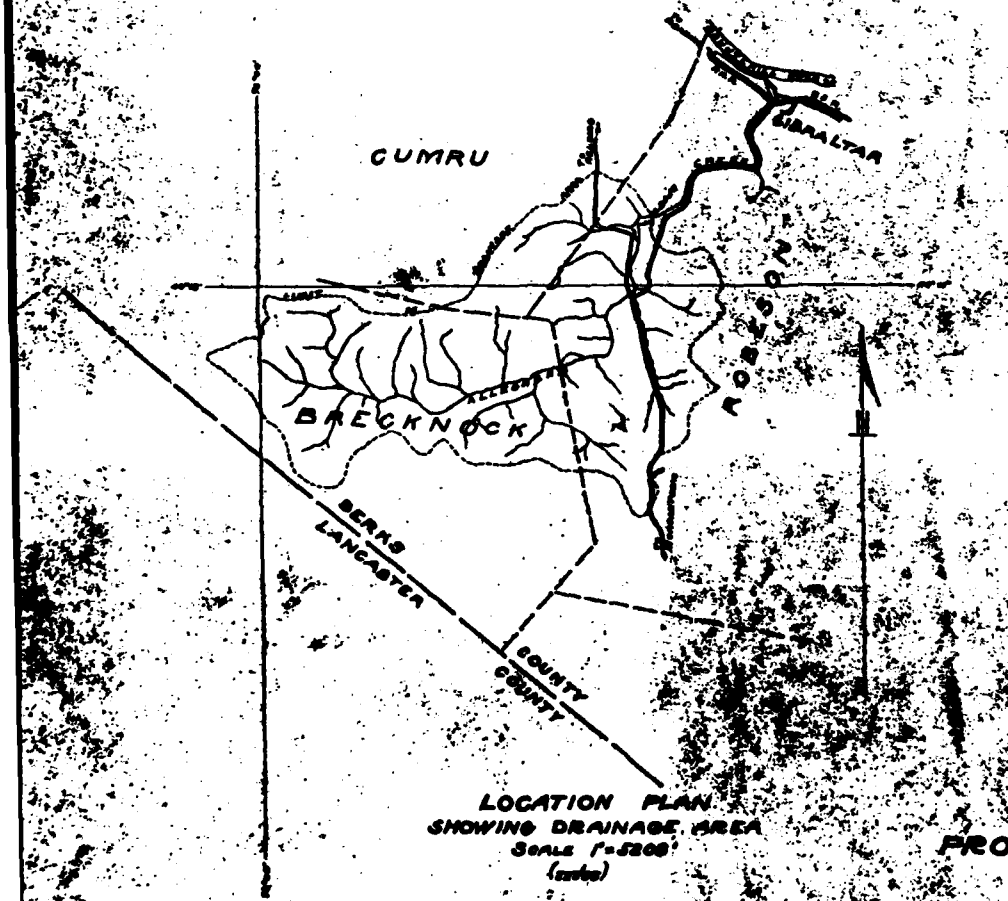
2

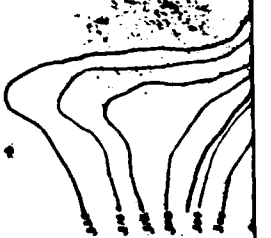
PLATE 2



CROSS SECTION 'A-A'
THROUGH PROPOSED DAM
SCALE - 1"=10'



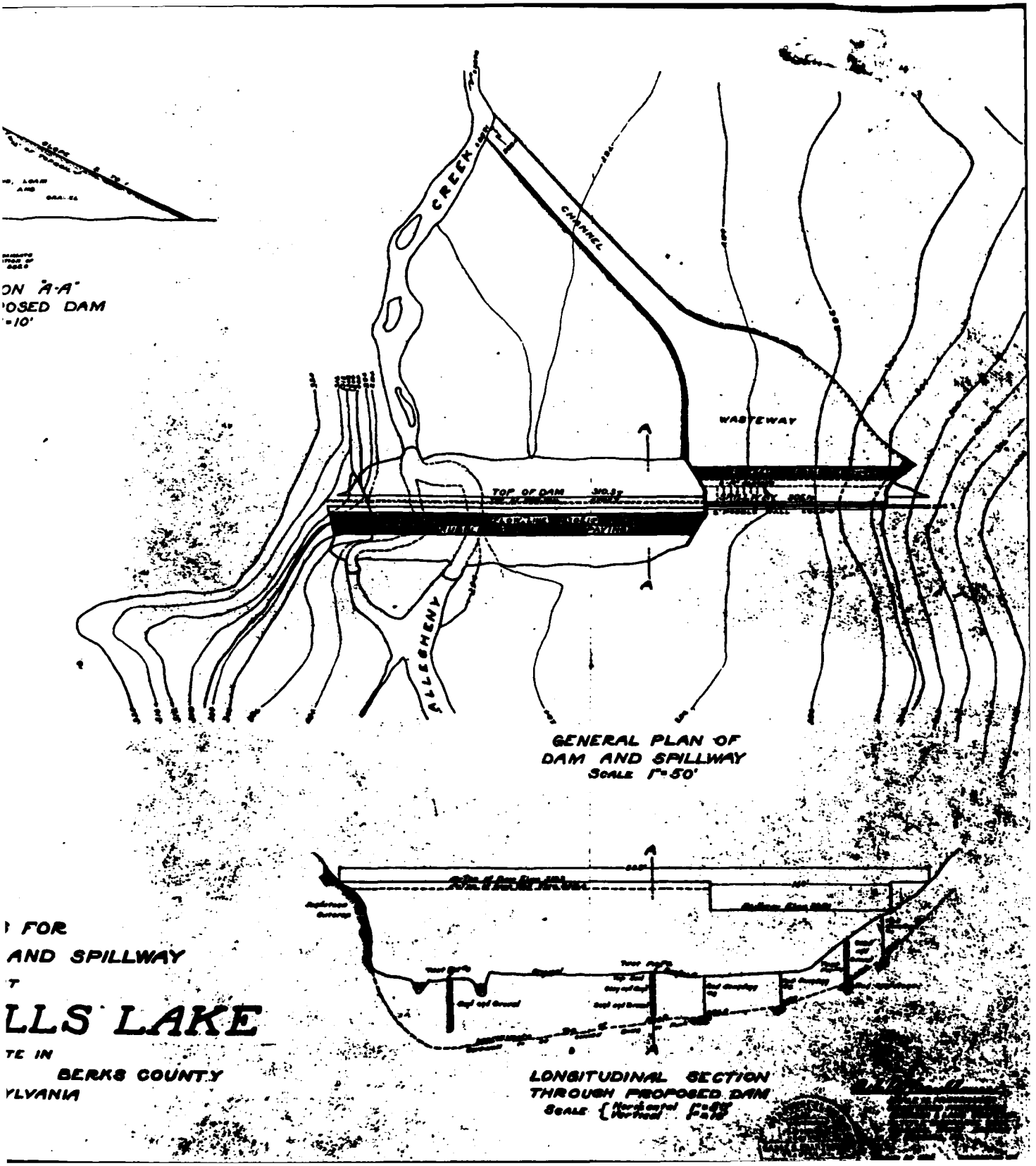
LOCATION PLAN
SHOWING DRAINAGE AREA
SCALE 1"=2000'
(scale)



PLANS FOR
PROPOSED DAM AND SPILLWAY
AT

GREEN HILLS LAKE

SITUATE IN
ROBESON TOWNSHIP BERKS COUNTY
PENNSYLVANIA
OCTOB



GENERAL PLAN OF
DAM AND SPILLWAY
SCALE 1"=50'

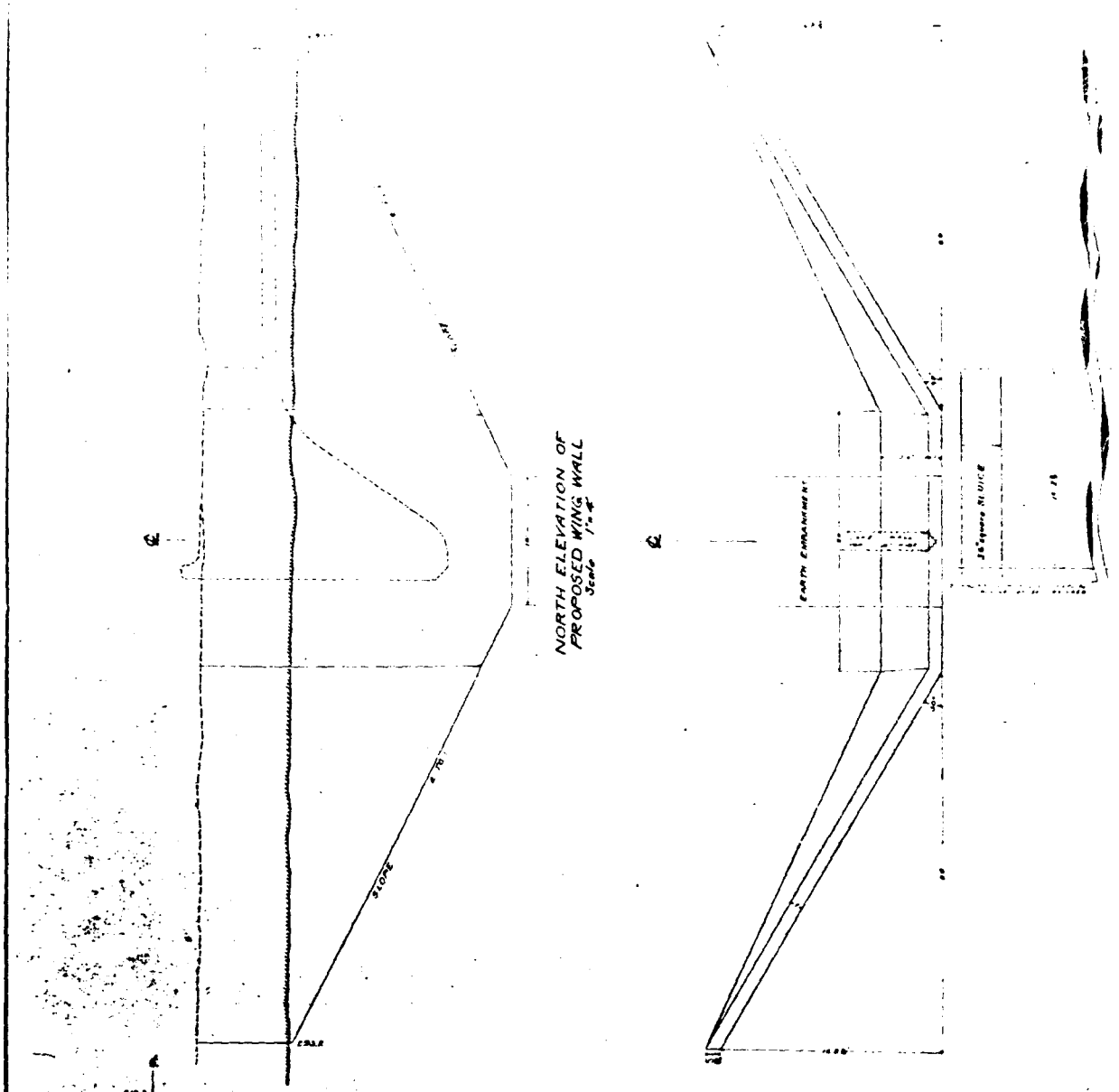
LONGITUDINAL SECTION
THROUGH PROPOSED DAM

ON "A-A"
OSED DAM
=10'

FOR
AND SPILLWAY
T

LLS LAKE

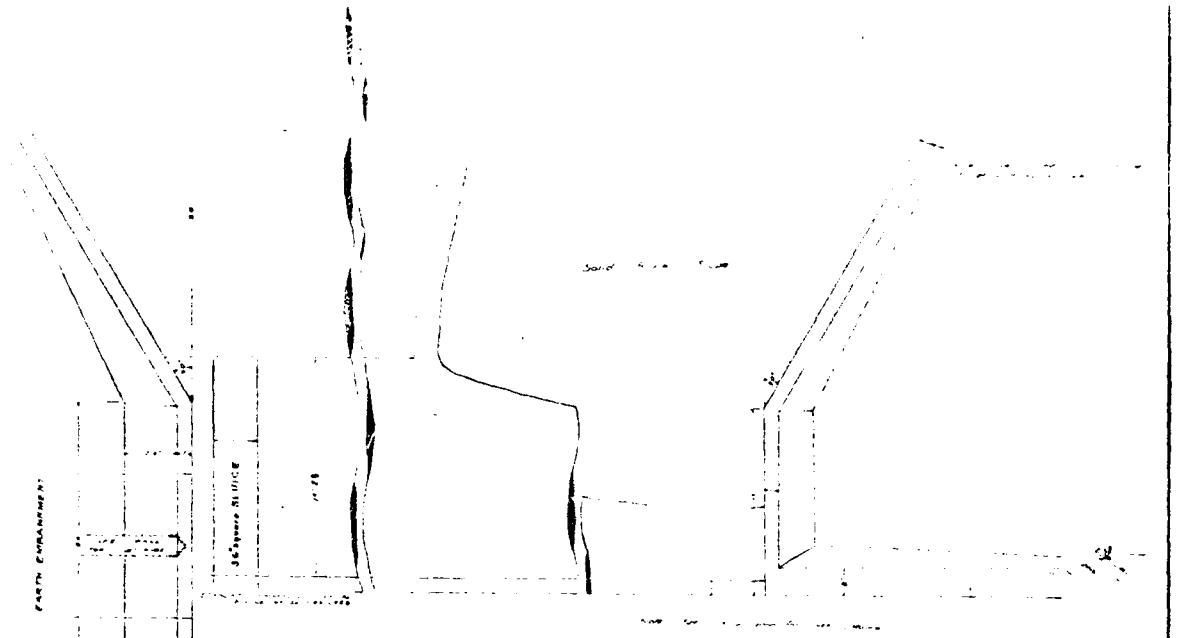
TE IN
BERKS COUNTY
YLVANIA



CROSS SECTION 'B-B'
THROUGH PROPOSED SPILLWAY
Scale 1"=4'

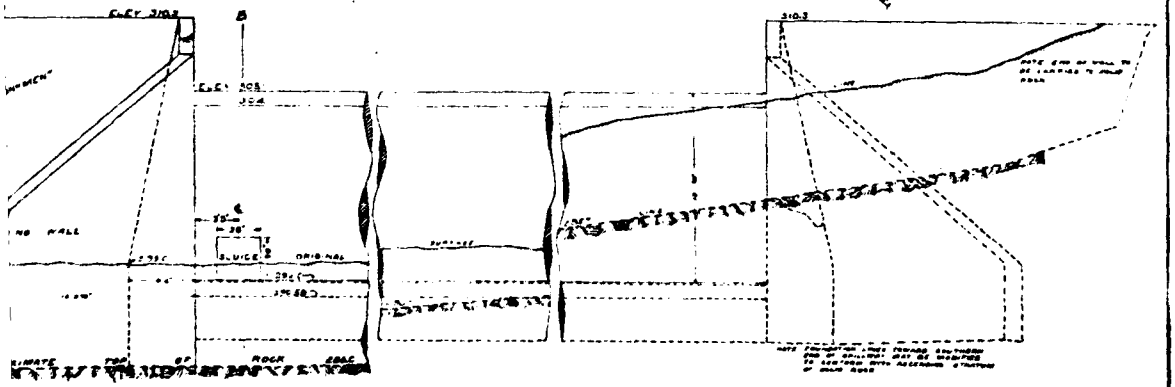
WEST ELE
PROPOSED
Scale

G-17-D/8



PLAN OF SPILLWAY
END WING WALLS
Scale 1"=4'

DETAIL PLANS FOR
SPILLWAY OF PROPOSED DAM
AT
GREEN HILLS LAKE
SITUATE IN
ROBESON TOWNSHIP BERKS COUNTY
PENNSYLVANIA

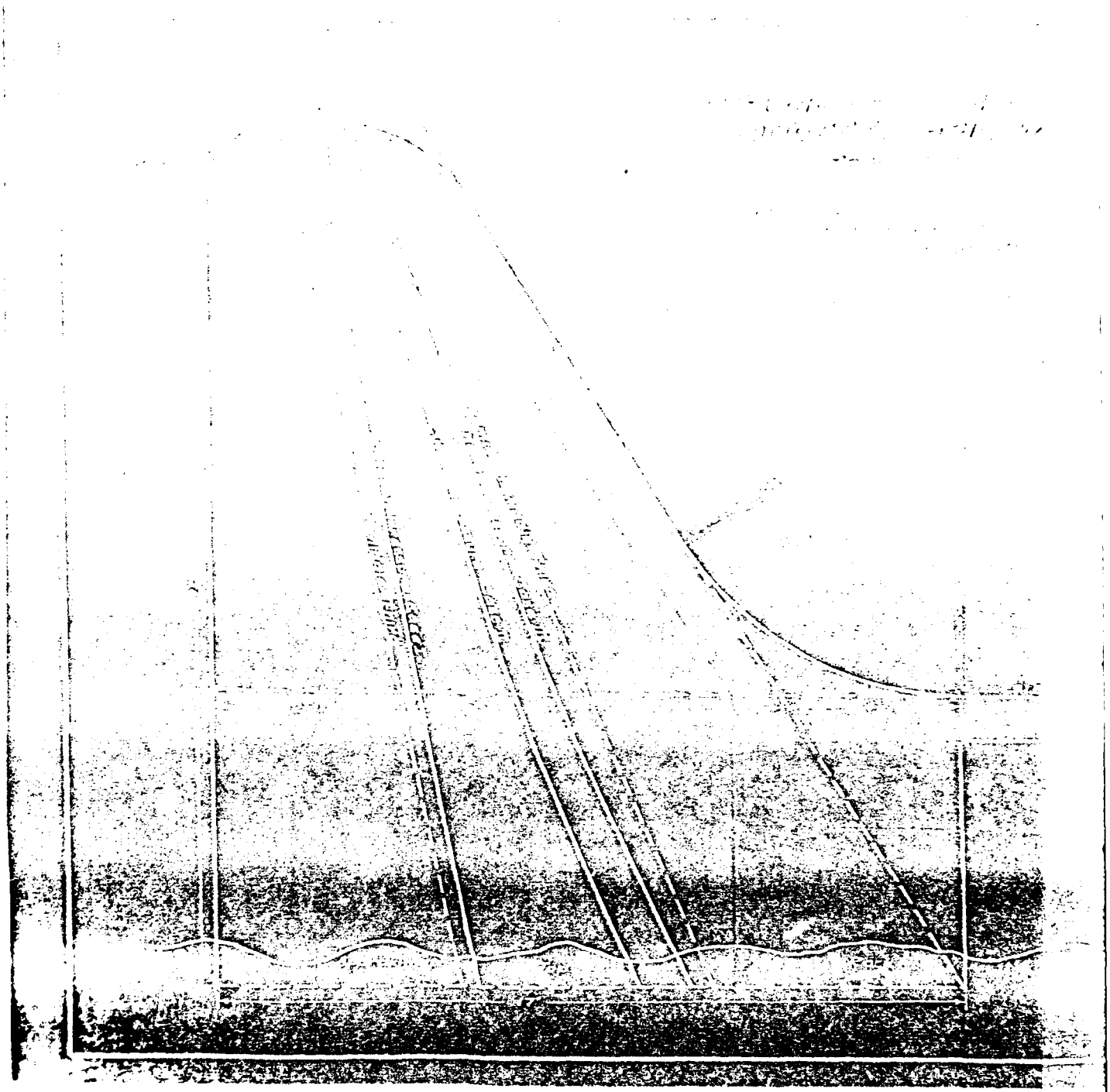


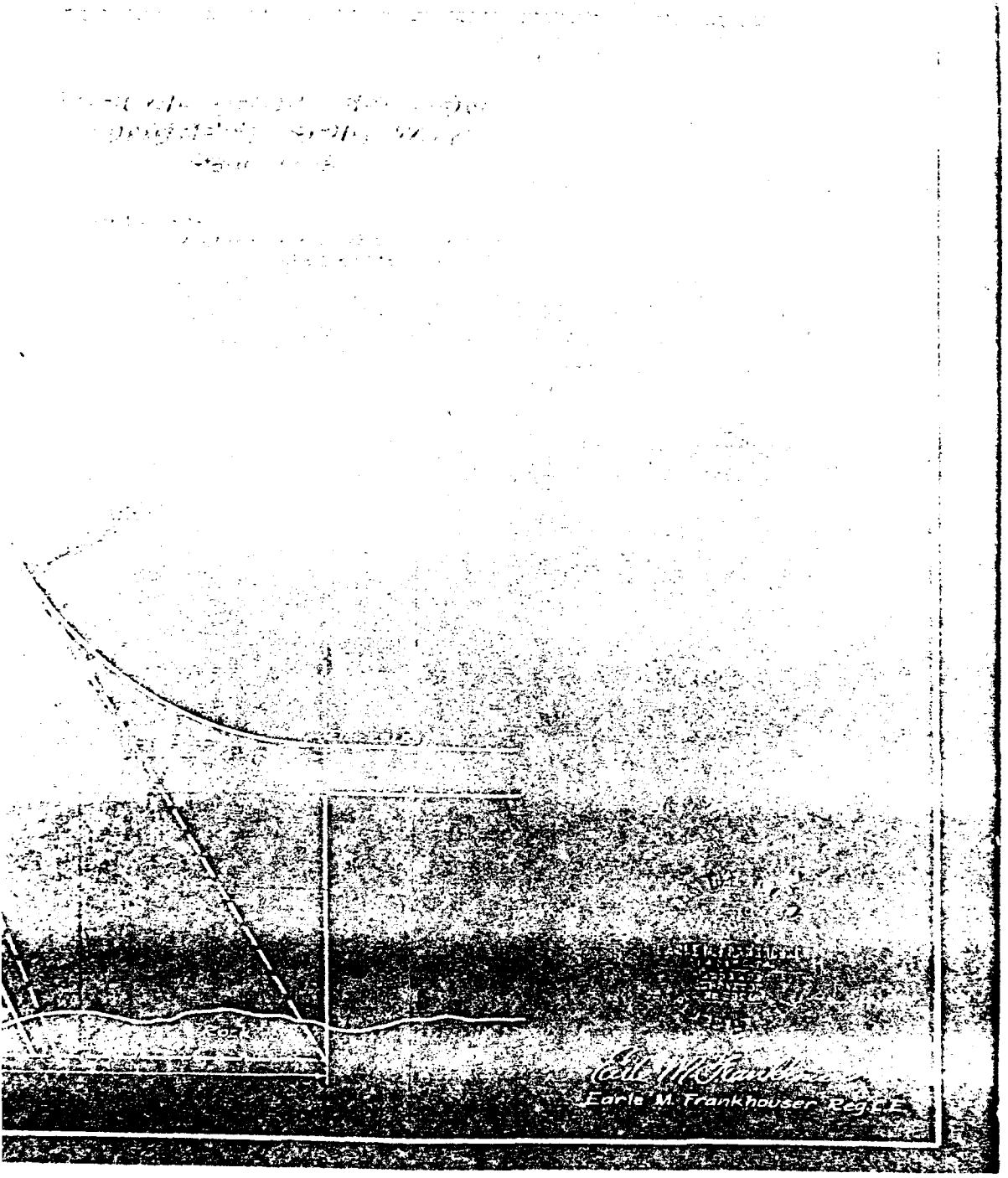
WEST ELEVATION OF
PROPOSED SPILLWAY
Scale 1"=4'

OCTOBER 1938
REVISED SEPTEMBER 6 1939

2

PLATE 3





2

PLATE 4

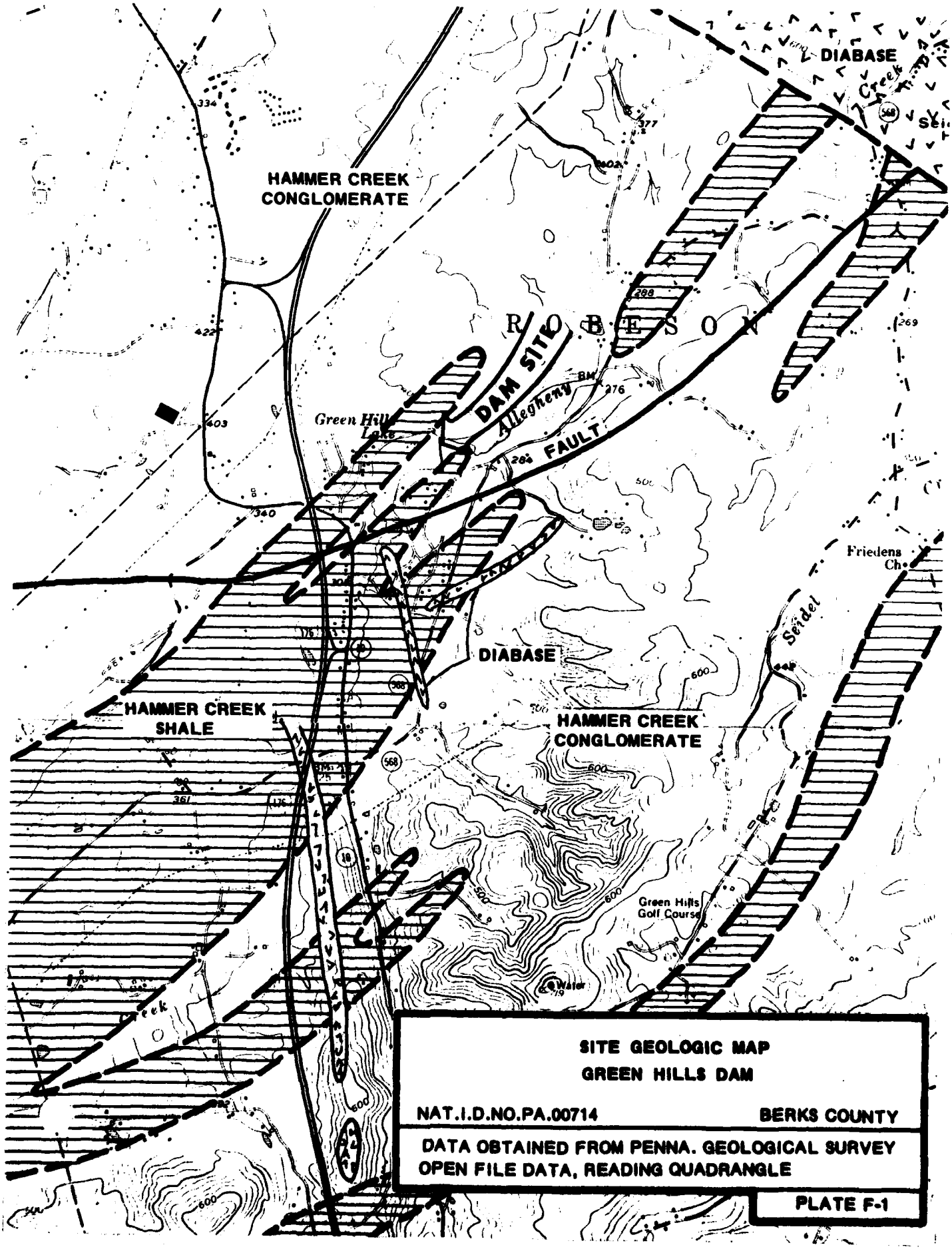
APPENDIX

F

SITE GEOLOGY
GREEN HILLS DAM

Green Hills Dam is located within the Triassic Lowlands Section of the Piedmont Physiographic Province. As shown in Plate F-1, the dam is founded upon the Triassic age Hammer Creek Formation consisting of conglomerate and shale. Well exposed red-brown interbeds of shale, sandstone and conglomerate occur at the right abutment area.

Bedding strikes north-northeast and dips 20 degrees to the northwest (upstream direction). A major set of joints strikes north-northwest and dips near vertical. The upstream dip of bedding and the high angle joint orientation are favorable conditions for minimizing seepage. The seepage observed downstream of the left abutment area may be a result of a combination of shallow bedrock and surface runoff.



SITE GEOLOGIC MAP
GREEN HILLS DAM

NAT.I.D.NO.PA.00714 **BERKS COUNTY**

DATA OBTAINED FROM PENNA. GEOLOGICAL SURVEY OPEN FILE DATA, READING QUADRANGLE

PLATE F-1